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Prepared By:  
Software Standards Validation Group  
National Computer Systems Laboratory  
National Institute of Standards and Technology  
Building 225, Room A266  
Gaithersburg, Maryland 20899

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Certificate Information

The following Ada implementation was tested and determined to pass ACVC 1.11. Testing was completed on August 05, 1992.

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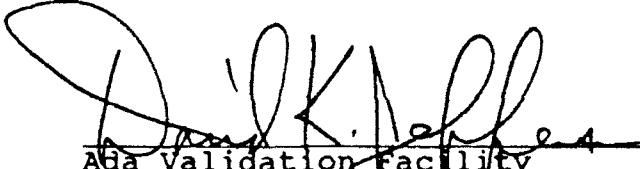
Host Computer System: SPARCStation 2 under SunOS, Version 4.1.1

Target Computer System: SPARCStation 2 under SunOS, Version 4.1.1

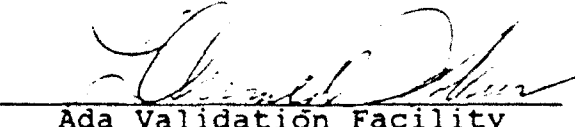
See section 3.1 for any additional information about the testing environment.

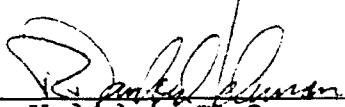
As a result of this validation effort, Validation Certificate 920805S1.11265 is awarded to DDC-I, Inc.. This certificate expires 2 years after ANSI/MIL-STD-1815B is approved by ANSI.


This report has been reviewed and is approved.

  
Ada Validation Facility  
Dr. David K. Jefferson  
Chief, Information Systems  
Engineering Division (ISED)

Computer Systems Laboratory (CLS)  
National Institute of Standards and Technology  
Building 225, Room A266  
Gaithersburg, MD 20899

  
Ada Validation Facility  
Mr. L. Arnold Johnson  
Manager, Software Standards  
Validation Group

  
for  
Ada Validation Organization  
Director, Computer & Software  
Engineering Division  
Institute for Defense Analyses  
Alexandria VA 22311

  
Ada Joint Program Office  
Dr. John Solomond  
Director  
Department of Defense  
Washington DC 20301

DECLARATION OF CONFORMANCE

The following declaration of conformance was supplied by the customer.

Customer: DDC-I, Inc.

Certificate Awardee: DDC-I, Inc.

Ada Validation Facility: National Institute of Standards and  
Technology  
Computer Systems Laboratory (CSL)  
Software Validation Group  
Building 225, Room A266  
Gaithersburg, Maryland 20899

ACVC Version: 1.11

Ada Implementation:

Compiler Name and Version: DACS Sun SPARC/SunOS Native Ada  
Compiler System, Version 4.6.1

Host Computer System: SPARCStation 2 under SunOS, Version  
4.1.1

Target Computer System: SPARCStation 2 under SunOS, Version  
4.1.1

Declaration:

I the undersigned, declare that I have no knowledge of deliberate deviations from the Ada Language Standard ANSI/MIL-STD-1815A ISO 8652-1987 in the implementation listed above.

Paul M. Harkness  
Customer Signature  
Company DDC-I, Inc.  
Title: President

Aug 6, 1992  
Date

Paul M. Harkness  
Certificate Awardee Signature  
Company DDC-I, Inc.  
Title: President

Aug 6, 1992  
Date

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## CHAPTER 1

### INTRODUCTION

The Ada implementation described above was tested according to the Ada Validation Procedures [Pro90] against the Ada Standard [Ada83] using the current Ada Compiler Validation Capability (ACVC). This Validation Summary Report (VSR) gives an account of the testing of this Ada implementation. For any technical terms used in this report, the reader is referred to [Pro90]. A detailed description of the ACVC may be found in the current ACVC User's Guide [UG89].

#### 1.1 USE OF THIS VALIDATION SUMMARY REPORT

Consistent with the national laws of the originating country, the Ada Certification Body may make full and free public disclosure of this report. In the United States, this is provided in accordance with the "Freedom of Information Act" (5 U.S.C. #552). The results of this validation apply only to the computers, operating systems, and compiler versions identified in this report.

The organizations represented on the signature page of this report do not represent or warrant that all statements set forth in this report are accurate and complete, or that the subject implementation has no nonconformities to the Ada Standard other than those presented. Copies of this report are available to the public from the AVF which performed this validation or from:

National Technical Information Service  
5285 Port Royal Road  
Springfield VA 22161

Questions regarding this report or the validation test results should be directed to the AVF which performed this validation or to:

Ada Validation Organization  
Computer and Software Engineering Division  
Institute for Defense Analyses  
1801 North Beauregard Street  
Alexandria VA 22311-1772

#### 1.2 REFERENCES

[Ada83] Reference Manual for the Ada Programming Language,  
ANSI/MIL-STD-1815A, February 1983 and ISO 8652-1987.

[Pro90] Ada Compiler Validation Procedures, Version 2.1, Ada Joint Program Office, August 1990.

[UG89] Ada Compiler Validation Capability User's Guide, 21 June 1989.

### 1.3 ACVC TEST CLASSES

Compliance of Ada implementations is tested by means of the ACVC. The ACVC contains a collection of test programs structured into six test classes: A, B, C, D, E, and L. The first letter of a test name identifies the class to which it belongs. Class A, C, D, and E tests are executable. Class B and class L tests are expected to produce errors at compile time and link time, respectively.

The executable tests are written in a self-checking manner and produce a PASSED, FAILED, or NOT APPLICABLE message indicating the result when they are executed. Three Ada library units, the packages REPORT and SPRT13, and the procedure CHECK\_FILE are used for this purpose. The package REPORT also provides a set of identity functions used to defeat some compiler optimizations allowed by the Ada Standard that would circumvent a test objective. The package SPRT13 is used by many tests for Chapter 13 of the Ada Standard. The procedure CHECK\_FILE is used to check the contents of text files written by some of the Class C tests for Chapter 14 of the Ada Standard. The operation of REPORT and CHECK\_FILE is checked by a set of executable tests. If these units are not operating correctly, validation testing is discontinued.

Class B tests check that a compiler detects illegal language usage. Class B tests are not executable. Each test in this class is compiled and the resulting compilation listing is examined to verify that all violations of the Ada Standard are detected. Some of the class B tests contain legal Ada code which must not be flagged illegal by the compiler. This behavior is also verified.

Class L tests check that an Ada implementation correctly detects violation of the Ada Standard involving multiple, separately compiled units. Errors are expected at link time, and execution is attempted.

In some tests of the ACVC, certain macro strings have to be replaced by implementation-specific values -- for example, the largest integer. A list of the values used for this implementation is provided in Appendix A. In addition to these anticipated test modifications, additional changes may be required to remove unforeseen conflicts between the tests and implementation-dependent characteristics. The modifications required for this implementation are described in section 2.3.

For each Ada implementation, a customized test suite is produced by the AVF. This customization consists of making the modifications described in the preceding paragraph, removing withdrawn tests (see section 2.1) and, possibly some inapplicable tests (see Section 3.2 and [UG89]).

In order to pass an ACVC an Ada implementation must process each test of the customized test suite according to the Ada Standard.

#### 1.4 DEFINITION OF TERMS

Ada Compiler	The software and any needed hardware that have to be added to a given host and target computer system to allow transformation of Ada programs into executable form and execution thereof.
Ada Compiler Validation Capability (ACVC)	The means for testing compliance of Ada implementations, Validation consisting of the test suite, the support programs, the ACVC Capability user's guide and the template for the validation summary (ACVC) report.
Ada Implementation	An Ada compiler with its host computer system and its target computer system.
Ada Joint Program (AJPO)	The part of the certification body which provides policy and guidance for the Ada certification Office system.
Ada Validation Facility (AVF)	The part of the certification body which carries out the procedures required to establish the compliance of an Ada implementation.
Ada Validation Organization (AVO)	The part of the certification body that provides technical guidance for operations of the Ada certification system.
Compliance of an Ada Implementation	The ability of the implementation to pass an ACVC version.
Computer System	A functional unit, consisting of one or more computers and associated software, that uses common storage for all or part of a program and also for all or part of the data necessary for the execution of the program; executes user-written or user-designated programs; performs user-designated data manipulation, including



arithmetic operations and logic operations; and that can execute programs that modify themselves during execution. A computer system may be a stand-alone unit or may consist of several inter-connected units.

Conformity	Fulfillment by a product, process or service of all requirements specified.
Customer	An individual or corporate entity who enters into an agreement with an AVF which specifies the terms and conditions for AVF services (of any kind) to be performed.
Declaration of Conformance	A formal statement from a customer assuring that conformity is realized or attainable on the Ada implementation for which validation status is realized.
Host Computer System	A computer system where Ada source programs are transformed into executable form.
Inapplicable test	A test that contains one or more test objectives found to be irrelevant for the given Ada implementation.
ISO	International Organization for Standardization.
LRM	The Ada standard, or Language Reference Manual, published as ANSI/MIL-STD-1815A-1983 and ISO 8652-1987. Citations from the LRM take the form "<section>.<subsection>:<paragraph>."
Operating System	Software that controls the execution of programs and that provides services such as resource allocation, scheduling, input/output control, and data management. Usually, operating systems are predominantly software, but partial or complete hardware implementations are possible.
Target Computer System	A computer system where the executable form of Ada programs are executed.
Validated Ada Compiler	The compiler of a validated Ada implementation.
Validated Ada Implementation	An Ada implementation that has been validated successfully either by AVF testing or by registration [Pro90].

Validation	The process of checking the conformity of an Ada compiler to the Ada programming language and of issuing a certificate for this implementation.
Withdrawn test	A test found to be incorrect and not used in conformity testing. A test may be incorrect because it has an invalid test objective, fails to meet its test objective, or contains erroneous or illegal use of the Ada programming language.

## CHAPTER 2

### IMPLEMENTATION DEPENDENCIES

#### 2.1 WITHDRAWN TESTS

Some tests are withdrawn by the AVO from the ACVC because they do not conform to the Ada Standard. The following 95 tests had been withdrawn by the Ada Validation Organization (AVO) at the time of validation testing. The rationale for withdrawing each test is available from either the AVO or the AVF. The publication date for this list of withdrawn tests is 91-08-02.

E28005C	B28006C	C32203A	C34006D	C35508I	C35508J
C35508M	C35508N	C35702A	C35702B	B41308B	C43004A
C45114A	C45346A	C45612A	C45612B	C45612C	C45651A
C46022A	B49008A	B49008B	A74006A	C74308A	B83022B
B83022H	B83025B	B83025D	B83026B	C83026A	C83041A
B85001L	C86001F	C94021A	C97116A	C98003B	BA2011A
CB7001A	CB7001B	CB7004A	CC1223A	BC1226A	CC1226B
BC3009B	BD1B02B	BD1B06A	AD1B08A	BD2A02A	CD2A21E
CD2A23E	CD2A32A	CD2A41A	CD2A41E	CD2A87A	CD2B15C
BD3006A	BD4008A	CD4022A	CD4022D	CD4024B	CD4024C
CD4024D	CD4031A	CD4051D	CD5111A	CD7004C	ED7005D
CD7005E	AD7006A	CD7006E	AD7201A	AD7201E	CD7204B
AD7206A	BD8002A	BD8004C	CD9005A	CD9005B	CDA201E
CE2107I	CE2117A	CE2117B	CE2119B	CE2205B	CE2405A
CE3111C	CE3116A	CE3118A	CE3411B	CE3412B	CE3607B
CE3607C	CE3607D	CE3812A	CE3814A	CE3902B	

#### 2.2 INAPPLICABLE TESTS

A test is inapplicable if it contains test objectives which are irrelevant for a given Ada implementation. The inapplicability criteria for some tests are explained in documents issued by ISO and the AJPO known as Ada Commentaries and commonly referenced in the format AI-ddddd. For this implementation, the following tests were determined to be inapplicable for the reasons indicated; references to Ada Commentaries are included as appropriate.

The following 201 tests have floating-point type declarations requiring more digits than SYSTEM.MAX\_DIGITS:

C24113L..Y (14 tests)	C35705L..Y (14 tests)
C35706L..Y (14 tests)	C35707L..Y (14 tests)
C35708L..Y (14 tests)	C35802L..Z (15 tests)

C45241L..Y (14 tests)	C45321L..Y (14 tests)
C45421L..Y (14 tests)	C45521L..Z (15 tests)
C45524L..Z (15 tests)	C45621L..Z (15 tests)
C45641L..Y (14 tests)	C46012L..Z (15 tests)

C24113I..K (3 TESTS) use a line length in the input file which exceeds 126 characters.

The following 20 tests check for the predefined type LONG\_INTEGER; for this implementation, there is no such type:

C35404C	C45231C	C45304C	C45411C	C45412C
C45502C	C45503C	C45504C	C45504F	C45611C
C45613C	C45614C	C45631C	C45632C	B52004D
C55B07A	B55B09C	B86001W	C86006C	CD7101F

C35404D, C45231D, B86001X, C86006E, and CD7101G check for a predefined integer type with a name other than INTEGER, LONG\_INTEGER, or SHORT\_INTEGER; for this implementation, there is no such type.

C35713B, C45423B, B86001T, and C86006H check for the predefined type SHORT\_FLOAT; for this implementation, there is no such type.

C35713D and B86001Z check for a predefined floating-point type with a name other than FLOAT, LONG\_FLOAT, or SHORT\_FLOAT; for this implementation, there is no such type.

C45531M..P and C45532M..P (8 tests) check fixed-point operations for types that require a SYSTEM.MAX\_MANTISSA of 47 or greater; for this implementation, MAX\_MANTISSA is less than 47.

C45624A..B (2 tests) check that the proper exception is raised if MACHINE\_OVERFLOW is FALSE for floating point types and the results of various floating-point operations lie outside the range of the base type; for this implementation, MACHINE\_OVERFLOW is TRUE.

C4A013B contains a static universal real expression that exceeds the range of this implementation's largest floating-point type; this expression is rejected by the compiler.

B86001Y uses the name of a predefined fixed-point type other than type DURATION; for this implementation, there is no such type.

C96005B uses values of type DURATION's base type that are outside the range of type DURATION; for this implementation, the ranges are the same.

CA2009C and CA2009F check whether a generic unit can be instantiated before its body (and any of its subunits) is compiled; this implementation creates a dependence on generic units as

allowed by AI-00408 and AI-00506 such that the compilation of the generic unit bodies makes the instantiating units obsolete. (See section 2.3.)

CD1009C checks whether a length clause can specify a non-default size for a floating-point type; this implementation does not support such sizes.

CD2A84A, CD2A84E, CD2A84I..J (2 tests), and CD2A84O use length clauses to specify non-default sizes for access types; this implementation does not support such sizes.

BA1001B, BD8001A, BD8003A, BD8004A..B (2 tests), and AD8011A use machine code insertions: this implementation provides no package MACHINE\_CODE.

The tests listed in the following table check that USE\_ERROR is raised if the given file operations are not supported for the given combination of mode and access method; this implementation supports these operations.

Test	File Operation	Mode	File Access Method
CE2102E	CREATE	OUT_FILE	SEQUENTIAL_IO
CE2102F	CREATE	INOUT_FILE	DIRECT_IO
CE2102J	CREATE	OUT_FILE	DIRECT_IO
CE2102N	OPEN	IN_FILE	SEQUENTIAL_IO
CE2102O	RESET	IN_FILE	SEQUENTIAL_IO
CE2102P	OPEN	OUT_FILE	SEQUENTIAL_IO
CE2102Q	RESET	OUT_FILE	SEQUENTIAL_IO
CE2102R	OPEN	INOUT_FILE	DIRECT_IO
CE2102S	RESET	INOUT_FILE	DIRECT_IO
CE2102T	OPEN	IN_FILE	DIRECT_IO
CE2102U	RESET	IN_FILE	DIRECT_IO
CE2102V	OPEN	OUT_FILE	DIRECT_IO
CE2102W	RESET	OUT_FILE	DIRECT_IO
CE3102F	RESET	Any Mode	TEXT_IO
CE3102G	DELETE	-----	TEXT_IO
CE3102I	CREATE	OUT_FILE	TEXT_IO
CE3102J	OPEN	IN_FILE	TEXT_IO
CE3102K	OPEN	OUT_FILE	TEXT_IO

The tests listed in the following table check the given file operations for the given combination of mode and access method; this implementation does not support these operations.

Test	File Operation	Mode	File Access Method
CE2105A	CREATE	IN_FILE	SEQUENTIAL_IO
CE2105B	CREATE	IN_FILE	DIRECT_IO
CE3109A	CREATE	IN_FILE	TEXT_IO

CE2203A checks that WRITE raises USE\_ERROR if the capacity of an external sequential file is exceeded; this implementation cannot restrict file capacity.

EE2401D uses an instantiation of DIRECT\_IO with an unconstrained array type; for this implementation, the maximum element size of the array type exceeds the implementation limit of 32Kbytes and so USE\_ERROR is raised.

CE2403A checks that WRITE raises USE\_ERROR if the capacity of an external direct file is exceeded; this implementation cannot restrict file capacity.

CE3111B and CE3115A associate multiple internal text files with the same external file and attempt to read from one file what was written to the other, which is assumed to be immediately available; this implementation buffers output. (See section 2.3.)

CE3304A checks that SET\_LINE\_LENGTH and SET\_PAGE\_LENGTH raise USE\_ERROR if they specify an inappropriate value for the external file; there are no inappropriate values for this implementation.

CE3413B checks that PAGE raises LAYOUT\_ERROR when the value of the page number exceeds COUNT'LAST; for this implementation, the value of COUNT'LAST is greater than 150000, making the checking of this objective impractical.

## 2.3 TEST MODIFICATIONS

Modifications (see section 1.3) were required for 69 tests.

The following tests were split into two or more tests because this implementation did not report the violations of the Ada Standard in the way expected by the original tests.

B22003A	B26001A	B26002A	B26005A	B28003A	B29001A	B33301B
B35101A	B37106A	B37301B	B37302A	B38003A	B38003B	B38009A
B38009B	B55A01A	B61001C	B61001F	B61001H	B61001I	B61001M
B61001R	B61001W	B67001H	B83A07A	B83A07B	B83A07C	B83E01C
B83E01D	B83E01E	B85001D	B85008D	B91001A	B91002A	B91002B
B91002C	B91002D	B91002E	B91002F	B91002G	B91002H	B91002I
B91002J	B91002K	B91002L	B95030A	B95061A	B95061F	B95061G
B95077A	B97103E	B97104G	BA1001A	BA1101B	BC1109A	BC1109C
BC1109D	BC1202A	BC1202F	BC1202G	BE2210A	BE2413A	

CA2009C and CA2009F were graded inapplicable by Evaluation

Modification as directed by the AVO. These tests contain instantiations of a generic unit prior to the compilation of that unit's body; as allowed by AI-00408 and AI-00506, the compilation of the generic unit bodies makes the compilation unit that contains the instantiations obsolete.

BC3204C and BC3205D were graded passed by Processing Modification as directed by the AVO. These tests check that instantiations of generic units with unconstrained types as generic actual parameters are illegal if the generic bodies contain uses of the types that require a constraint. However, the generic bodies are compiled after the units that contain the instantiations, and this implementation creates a dependence of the instantiating units on the generic units as allowed by AI-00408 and AI-00506 such that the compilation of the generic bodies makes the instantiating units obsolete--no errors are detected. The processing of these tests was modified by re-compiling the obsolete units; all intended errors were then detected by the compiler.

CD2A83A was graded passed by Test Modification as directed by the AVO. This test uses a length clause to specify the collection size for an access type whose designated type is STRING; eight designated objects are allocated, with a combined length of 30 characters. Because of this implementation's heap-management strategy and alignment requirements, the collection size at line 22 had to be increased to 812.

CE3111B and CE3115A were graded inapplicable by Evaluation Modification as directed by the AVO. The tests assume that output from one internal file is unbuffered and may be immediately read by another file that shares the same external file. This implementation raises END\_ERROR on the attempts to read at lines 87 and 101, respectively.

## CHAPTER 3

### PROCESSING INFORMATION

#### 3.1 TESTING ENVIRONMENT

The Ada implementation tested in this validation effort is described adequately by the information given in the initial pages of this report.

For technical information about this Ada implementation, contact:

Johan O. Nielsen  
DDC International A/S  
Gl. Lundtoftevej 1B  
DK-2800 Lyngby  
DENMARK

Telephone: + 45 42 87 11 44  
Telefax: + 45 42 87 22 17

For sales information about this Ada implementation, contact:

Jennifer Collins  
DDC-I, Inc.  
410 North 44th Street, Suite 320  
Phoenix, AZ 85008  
Telephone: 602-275-7172  
Telefax: 602-275-7502

Testing of this Ada implementation was conducted at the customer's site by a validation team from the AVF.

#### 3.2 SUMMARY OF TEST RESULTS

An Ada Implementation passes a given ACVC version if it processes each test of the customized test suite in accordance with the Ada Programming Language Standard, whether the test is applicable or inapplicable; otherwise, the Ada Implementation fails the ACVC [Pro90].

For all processed tests (inapplicable and applicable), a result was obtained that conforms to the Ada Programming Language Standard.

The list of items below gives the number of ACVC tests in various categories. All tests were processed, except those that were withdrawn because of test errors (item b; see section 2.1), those that require a floating-point precision that exceeds the



implementation's maximum precision (item e; see section 2.2), and those that depend on the support of a file system -- if none is supported (item d). All tests passed, except those that are listed in sections 2.1 and 2.2 (counted in items b and f, below).

a) Total Number of Applicable Tests	3785	
b) Total Number of Withdrawn Tests	95	
c) Processed Inapplicable Tests	290	
d) Non-Processed I/O Tests	0	
e) Non-Processed Floating-Point Precision Tests	0	
f) Total Number of Inapplicable Tests	290	(c+d+e)
g) Total Number of Tests for ACVC 1.11	4170	(a+b+f)

### 3.3 TEST EXECUTION

A magnetic tape containing the customized test suite (see section 1.3) was taken on-site by the validation team for processing. The contents of the magnetic tape were loaded directly onto the host computer.

After the test files were loaded onto the host computer, the full set of tests was processed by the Ada implementation.

The tests were compiled, linked, and executed on the host/target computer system. The results were captured on the host/target computer system.

Testing was performed using command scripts provided by the customer and reviewed by the validation team. See Appendix B for a complete listing of the processing options for this implementation. The options invoked explicitly for validation testing during this test were:

All default options were invoked for the Ada compiler. However, the list option was invoked for B-Tests, E-Tests, modified tests, and supporting packages:

-list

Test output, compiler and linker listings, and job logs were captured on magnetic tape and archived at the AVF. The listings examined on-site by the validation team were also archived.

# APPENDIX A

## MACRO PARAMETERS

This appendix contains the macro parameters used for customizing the ACVC. The meaning and purpose of these parameters are explained in [UG89]. The parameter values are presented in two tables. The first table lists the values that are defined in terms of the maximum input-line length, which is the value for \$MAX\_IN\_LEN--also listed here. These values are expressed here as Ada string aggregates, where "V" represents the maximum input-line length.

Macro Parameter	Macro Value
\$MAX_IN_LEN	126 -- Value of V
\$BIG_ID1	(1..V-1 => 'A', V => '1')
\$BIG_ID2	(1..V-1 => 'A', V => '2')
\$BIG_ID3	(1..V/2 => 'A') & '3' & (1..V-1-V/2 => 'A')
\$BIG_ID4	(1..V/2 => 'A') & '4' & (1..V-1-V/2 => 'A')
\$BIG_INT_LIT	(1..V-3 => '0') & "298"
\$BIG_REAL_LIT	(1..V-5 => '0') & "690.0"
\$BIG_STRING1	'"' & (1..V/2 => 'A') & '"'
\$BIG_STRING2	'"' & (1..V-1-V/2 => 'A') & '1' & '"'
\$BLANKS	(1..V-20 => ' ')
\$MAX_LEN_INT_BASED_LITERAL	"2:" & (1..V-5 => '0') & "11:"
\$MAX_LEN_REAL_BASED_LITERAL	"16:" & (1..V-7 => '0') & "F.E:"
\$MAX_STRING_LITERAL	'"' & (1..V-2 => 'A') & '"'

The following table contains the values for the remaining macro parameters.

Macro Parameter	Macro Value
ACC_SIZE	: 32
ALIGNMENT	: 4
COUNT_LAST	: 2_147_483_647
DEFAULT_MEM_SIZE	: 2048*1024
DEFAULT_STOR_UNIT	: 8
DEFAULT_SYS_NAME	: DACS_SPARC
DELTA_DOC	: 2#1.0#E-31
ENTRY_ADDRESS	: SYSTEM."-"(16#080008B8#)
ENTRY_ADDRESS1	: SYSTEM."-"(16#08000898#)
ENTRY_ADDRESS2	: SYSTEM."-"(16#08000878#)
FIELD_LAST	: 35
FILE_TERMINATOR	: ' '
FIXED_NAME	: NO_SUCH_TYPE
FLOAT_NAME	: NO_SUCH_TYPE
FORM_STRING	: ""
FORM_STRING2	: "CANNOT_RESTRICT_FILE_CAPACITY"
GREATER_THAN_DURATION	: 100000.0
GREATER_THAN_DURATION_BASE_LAST	: 200000.0
GREATER_THAN_FLOAT_BASE_LAST	: 16#1.0#E+32
GREATER_THAN_FLOAT_SAFE_LARGE	: 16#5.FFFF_F0#E+31
GREATER_THAN_SHORT_FLOAT_SAFE_LARGE	: 1.0E308
HIGH_PRIORITY	: 31
ILLEGAL_EXTERNAL_FILE_NAME1	: /NODIRECTORY1/FILENAME1
ILLEGAL_EXTERNAL_FILE_NAME2	: /NODIRECTORY2/FILENAME2
INAPPROPRIATE_LINE_LENGTH	: -1
INAPPROPRIATE_PAGE_LENGTH	: -1
INCLUDE_PRAGMA1	: PRAGMA INCLUDE ("A28006D1.TST")
INCLUDE_PRAGMA2	: PRAGMA INCLUDE ("B28006E1.TST")
INTEGER_FIRST	: -2147483648
INTEGER_LAST	: 2147483647
INTEGER_LAST_PLUS_1	: 2147483648
INTERFACE_LANGUAGE	: AS
LESS_THAN_DURATION	: -75000.0
LESS_THAN_DURATION_BASE_FIRST	: -131073.0
LINE_TERMINATOR	: ' '
LOW_PRIORITY	: 0
MACHINE_CODE_STATEMENT	: NULL;
MACHINE_CODE_TYPE	: NO_SUCH_TYPE

MANTISSA_DOC	: 31
MAX_DIGITS	: 15
MAX_INT	: 2147483647
MAX_INT_PLUS_1	: 2147483648
MIN_INT	: -2147483648
NAME	: NO_SUCH_TYPE_AVAILABLE
NAME_LIST	: DACS_SPARC
NAME_SPECIFICATION1	:
	/usry/ada/DACS_Sparc_461_validation/work/X2120A
NAME_SPECIFICATION2	:
	/usry/ada/DACS_Sparc_461_validation/work/X2120B
NAME_SPECIFICATION3	:
	/usry/ada/DACS_Sparc_461_validation/work/X3119A
NEG_BASED_INT	: 16#F000000E#
NEW_MEM_SIZE	: 2097152
NEW_STOR_UNIT	: 8
NEW_SYS_NAME	: DACS_SPARC
PAGE_TERMINATOR	: ' '
RECORD_DEFINITION	: NEW_INTEGER
RECORD_NAME	: MACHINE_INSTRUCTION
TASK_SIZE	: 32
TASK_STORAGE_SIZE	: 1024
TICK	: 2#1.0#E-14
VARIABLE_ADDRESS	: SYSTEM."-(16#08000918#)
VARIABLE_ADDRESS1	: SYSTEM."-(16#080009F8#)
VARIABLE_ADDRESS2	: SYSTEM."-(16#080008D8#)
YOUR_PRAGMA	: N_A --test withdrawn

## APPENDIX B

### COMPILATION SYSTEM OPTIONS

The compiler options of this Ada implementation, as described in this Appendix, are provided by the customer. Unless specifically noted otherwise, references in this appendix are to compiler documentation and not to this report.

The Ada Compiler compiles all program units within the specified source file and inserts the generated objects into the current program library. Compiler options are provided to allow the user control of optimization, run-time checks, and compiler input and output options such as list files, configuration files, and the program library used.

The input to the compiler consists of the source file, the configuration file (which controls the format of the list file), and the compiler options. Section 5.1 provides a list of all compiler options, and Section 5.2 describes the source and configuration files.

Output consists of an object placed in the program library, diagnostic messages, and optional listings. The configuration file and the compiler options specify the format and contents of the list information. Output is described in Section 5.3.

If any diagnostic messages are produced during the compilation, they are output in the diagnostic file and on the current output file. The diagnostic file and the diagnostic message format are described in Section 5.3.2.

The compiler uses a program library during the compilation. The compilation unit may refer to units from the program library, and an internal representation of the compilation unit will be included in the program library as a result of a successful compilation. The program library is described in Chapter 3. Section 5.4 briefly describes how the Ada compiler uses the library.

### 5.1 Invocation Command

Invoke the Ada compiler with the following command:

```
ada {<option>} <source-file-name> {<source-file-name>}
```

### 5.1.1 Summary of Options

This section presents a summary of options supported by the compiler.

OPTIONS	DESCRIPTION	REFERENCE
<b>-auto_inline</b>	Small local subprograms are automatically inline expanded.	5.1.2
<b>-nocheck &lt;keyword&gt;{,&lt;keyword&gt;}</b>	Suppress generation of run-time constraint checks.	5.1.3
<b>-configuration &lt;file-name&gt;</b>	Specifies the file used by the compiler.	5.1.4
<b>-debug</b>	Specifies that information for the DDC-I Symbolic Ada Debugger is to be generated.	5.1.5
<b>-library &lt;file-name&gt;</b>	Specifies the program library to be used.	5.1.6
<b>-list</b>	Creates a source list file.	5.1.7
<b>-machine_code</b>	Generates a machine code dump for the compilation.	5.1.8
<b>-optimize &lt;keyword&gt;{,&lt;keyword&gt;}</b>	Specifies compiler optimizations.	5.1.9
<b>-profile</b>	Specifies that code for profiling is to be generated.	5.1.10
<b>-progress</b>	Displays compiler progress.	5.1.11
<b>-nosave_source</b>	The source is not saved in the program library.	5.1.12
<b>-warnings</b>	Suppress warnings from the compiler.	5.1.13
<b>-xref</b>	Creates a cross reference listing.	5.1.14

Example:

```
$ ada -list testprog
```

This example compiles the source file testprog and generates a list file with the name testprog.lis.

Example:

```
$ ada -lib my_library test
```

This example compiles the source file test into the library my\_library.

Default values exist for options as indicated in the following sections. Option names may be abbreviated (characters omitted from the right) as long as no ambiguity arises.



### 5.1.2 AUTO\_INLINE

Syntax:

**-auto\_line**

This option specifies whether local subprograms should be inline expanded. The inline expansion only occurs if the subprogram contains no more than 3 object declarations (and no other declarations), no more than 5 statements and no exception handler and if the subprogram fulfills the requirements defined for pragma inline. A warning is issued when automatic inline expansion is performed.

### 5.1.3 NOCHECK

Syntax:

**-nocheck <keyword>{,<keyword>}**

By default, all run-time checks listed below will be generated by the compiler. The following explicit checks can be suppressed:

<b>ALL</b>	Suppress all checks.
<b>INDEX</b>	Index check.
<b>ACCESS</b>	Check for access values being non NULL.
<b>DISCRIMINANT</b>	Checks for discriminated fields.
<b>LENGTH</b>	Array length check.
<b>RANGE</b>	Checks for values being in range.
<b>OVERFLOW</b>	Explicit overflow checks.
<b>ELABORATION</b>	Checks for subprograms being elaborated.
<b>STORAGE</b>	Checks for sufficient storage available.

Note that the Division\_check suppression mentioned in ARM 11.7 is not implemented.

### 5.1.4 CONFIGURATION\_FILE

Syntax:

**-configuration <file-name>**

This option specifies the configuration file to be used by the compiler. The configuration file



allows the user to format compiler listings, set error limits, etc. If the option is omitted the configuration file designated by the name "config" is used by default. Section 5.2.2 contains a description of the configuration file.

### 5.1.5 DEBUG

Syntax:

**-debug**

This option specifies that information for the DDC-I Symbolic Ada Debugger is to be generated. Please note that no extra information is included in the code or data generated.

### 5.1.6 LIBRARY

Syntax:

**-library <library-name>**

This option specifies the current sublibrary that will be used in the compilation and will receive the object when the compilation is complete. By specifying a current sublibrary, the current program library (current sublibrary and ancestors up to root) is also implicitly specified.

If this option is omitted, the sublibrary designated by the environment variable name `ADA_LIBRARY` is used as the current sublibrary. Section 5.4 describes how the Ada compiler uses the library.

### 5.1.7 LIST

Syntax:

**-list**

**-list** specifies that a source listing will be produced. The source listing is written on the list file, which has the name of the source file with the extension ".lis". Section 5.3.1.1 contains a description of the source listing.

### 5.1.8 MACHINE\_CODE

Syntax:

**-machine\_code**

Dump a machine code list of the compiled code at standard output. The instructions are dumped symbolically, but addresses are not. Calls are described by a "patch", which consists of a unit

number and an entry number. The unit number is a unique number defining the library unit and the entry number is the number of the subprogram within that unit.

### 5.1.9 OPTIMIZE

Syntax:

**-optimize <keyword>{,<keyword>}**

This option specifies which optimizations will be performed during code generation. Default is no optimizations.

Selection of optimizations can be done in two basic ways.

- 1) Selecting individual optimizations.
- 2) Selecting predefined classes of optimizations.

**[NO]LOOP\_REGISTERS[=<number-of-iterations>]**

Controls the extent to which registers are allocated to variables in loops, particularly inner loops.

It is possible to specify an optimization level, where the level specifies the number of times the optimizer shall loop through the code. If no level is specified only one loop will be performed.

**[NO]COMMON\_SUBEXPRESSION\_ELIMINATION[=<number-of-iterations>]**

Specify to which extent common subexpression elimination should be performed.

It is possible to specify an optimization level, where the level specifies the number of times the optimizer shall loop through the code. If no level is specified only one loop will be performed.

**[NO]COPY\_PROPAGATION[=<number-of-iterations>]**

Specify to which extent copy propagation should be performed.

It is possible to specify an optimization level, where the level specifies the number of times the optimizer shall loop through the code. If no level is specified only one loop will be performed.

**[NO]CONSTANT\_FOLDING**

Controls whether arithmetic expressions which have become static due to other optimizations are calculated at compile time and folded into the code.

**[NO]LOOP\_UNROLLING**

Performs unrolling of static loops into sequential code. The algorithm for deciding whether a loop is a candidate for unrolling is given in the Reference Manual.

**[NO]LOOP\_INVARIANT\_CODE\_MOTION**

Controls the movement of invariant code outside of loops.

**[NO]DEAD\_CODE\_REMOVAL[=<number-of-iterations>]**

Controls whether dead code should be removed or not. Dead code can occur when conditions become static or when a variable is not used anymore. Please note that this optimization can be a very time consuming.

It is possible to specify an optimization level, where the level specifies the number of times the optimizer shall loop through the code. If no level is specified only one loop will be performed.

The following options select a predefined level of optimizations:

- LOW** - Selects a predefined set of optimizations equal to the following list:  
 LOOP\_REGISTERS, COMMON\_SUBEXPR,  
 COPY\_PROPAGATION, CONSTANT\_FOLDING,  
 NODEAD\_CODE\_REMOVAL, LOOP\_UNROLLING,  
 LOOP\_INVARIANT\_CODE\_MOTION
- MEDIUM** - Selects a predefined set of optimizations equal to the following list:  
 LOOP\_REGISTERS=25, COMMON\_SUBEXPR=25,  
 COPY\_PROPAGATION=25, CONSTANT\_FOLDING,  
 DEAD\_CODE\_REMOVAL, LOOP\_UNROLLING,  
 LOOP\_INVARIANT\_CODE\_MOTION
- HIGH** - Selects a predefined set of optimizations equal to the following list:  
 LOOP\_REGISTERS=1000, COMMON\_SUBEXPR=1000,  
 COPY\_PROPAGATION=1000, CONSTANT\_FOLDING,  
 DEAD\_CODE\_REMOVAL=1000, LOOP\_UNROLLING,  
 LOOP\_INVARIANT\_CODE\_MOTION
- ALL** - Equivalent to HIGH

Example:

```
$ ada -optimize all example_1
```

Both of these commands compile the program with all the optimizations active at their highest levels.

```
$ ada -opt low,loop_reg=1000,noloop_unroll) example_2
```

This command compile the program with low optimizations, but no loop\_unrolling is wanted and registers should be used to the greatest extent possible in loops.



### 5.1.10 PROFILE

Syntax:

**-profile**

This option specifies that code for profiling shall be generated. This option in conjunction with the profile linker option enables profiling of an executable program.

### 5.1.11 PROGRESS

Syntax:

**-progress**

When this option is given, the compiler will output data about which pass the compiler is currently running.

### 5.1.12 NOSAVE\_SOURCE

Syntax:

**-nosave\_source**

When -nosave is specified, source code will not be retained in the program library, this save some space in the sublibrary. The default is to save a copy of the compiled source code in the program library. Hereby the user is always certain of what version of the source code compiled. The source code may be displayed from the sublibrary with the PLU Type command.

### 5.1.13 WARNINGS

Syntax:

**-warnings**

Suppress warnings from the compiler in the diagnostics file. All diagnostics will always come on standard output, only the contents of the diagnostics file is affected by the warnings option. If a compilation only generates warnings and the warnings option is specifies no diagnostics file is created.

### Syntax:

A cross-reference listing can be requested by the user by means of the option `-ref` in conjunction with option `list`. If the `xref` option is given and no severe or fatal errors are found during the compilation, the cross-reference listing is written to the `list` file. The cross-reference listing is described in Section 5.3.1.3.

**<source-file-name> {<source-file-name>}**

The compilation starts with the leftmost file name in the file name list, and ends with the rightmost. If the list of file names includes a file name with wildcards, the files matching the wildcard name are compiled in alphabetical order. If any file name occurs several times in the list of file names, the file is compiled several times, i.e. one file is compiled as many times as its name occurs in the list of file names.

The allowed format of the source text is described in Section 5.2.1.

Input to the compiler consists of the command line options, a list of source text files and, optionally, a configuration file.

The user submits one file containing a source text in each compilation. The source text may consist of one or more compilation units (see ARM Section 10.1).

The format of the source text must be in ISO-FORMAT ASCII. This format requires that the source text is a sequence of ISO characters (ISO standard 646), where each line is terminated by either one of the following termination sequences (CR means carriage return, VT means vertical tabulation, LF means line feed, and FF means form feed):

- 1) A sequence of one or more CRs, where the sequence is neither immediately preceded nor immediately followed by any of the characters VT, LF, or FF.
- 2) Any of the characters VT, LF, or FF, immediately preceded and followed by a sequence



of zero or more CRs.

In general, ISO control characters are not permitted in the source text with the following exceptions:

- 1) The horizontal tabulation (HT) character may be used as a separator between lexical units.
- 2) LF, VT, FF, and CR may be used to terminate lines, as described above.

The maximum number of characters in an input line is determined by the contents of the configuration file (see Section 5.1.4). The control characters CR, VT, LF, and FF are not considered a part of the line. Lines containing more than the maximum number of characters are truncated and an error message is issued.

### 5.2.2 Configuration File

Certain processing characteristics of the compiler, such as format of input and output, and error limit, may be modified by the user. These characteristics are passed to the compiler by means of a configuration file, which is a standard SunOS text file. The contents of the configuration file must be an Ada positional aggregate, written on one line, of the type `CONFIGURATION_RECORD`, which is described below.

The configuration file "config" is not accepted by the compiler in the following cases:

- 1) The syntax does not conform with the syntax for positional Ada aggregates.
- 2) A value is outside the ranges specified.
- 3) A value is not specified as a literal.
- 4) `LINES_PER_PAGE` is not greater than `TOP_MARGIN + BOTTOM_MARGIN`.
- 5) The aggregate occupies more than one line.

If the compiler is unable to accept the configuration file, an error message is written on the current output file and the compilation is terminated.

This is the record whose values must appear in aggregate form within the configuration file. The record declaration makes use of some other types (given below) for the sake of clarity.

```
type CONFIGURATION_RECORD is
  record
    IN_FORMAT      : INFORMATTING;
    OUT_FORMAT     : OUTFORMATTING;
    ERROR_LIMIT    : INTEGER;
  end record;

type INPUT_FORMATS is (ASCII);
```

```

type INFORMATTING is
  record
    INPUT_FORMAT      : INPUT_FORMATS;
    INPUT_LINELENGTH  : INTEGER range 70..250;
  end record;

type OUTFORMATTING is
  record
    LINES_PER_PAGE    : INTEGER range 30..100;
    TOP_MARGIN        : INTEGER range 4.. 90;
    BOTTOM_MARGIN      : INTEGER range 0.. 90;
    OUT_LINELENGTH     : INTEGER range 80..132;
    SUPPRESS_ERRORNO   : BOOLEAN;
  end record;

```

The outformatting parameters have the following meaning:

- 1) LINES\_PER\_PAGE: specifies the maximum number of lines written on each page (including top and bottom margin).
- 2) TOP\_MARGIN: specifies the number of lines on top of each page used for a standard heading and blank lines. The heading is placed in the middle lines of the top margin.
- 3) BOTTOM\_MARGIN: specifies the minimum number of lines left blank in the bottom of the page. The number of lines available for the listing of the program is LINES\_PER\_PAGE - TOP\_MARGIN - BOTTOM\_MARGIN.
- 4) OUT\_LINELENGTH: specifies the maximum number of characters written on each line. Lines longer than OUT\_LINELENGTH are separated into two lines.
- 5) SUPPRESS\_ERRORNO: specifies the format of error messages (see Section 5.3.2.3).

The name of a user-supplied configuration file can be passed to the compiler through the -c option. DDC-I supplies a default configuration file (config) with the following content:

```
((ASCII, 132), (48,5,3,100,FALSE), 200)
```

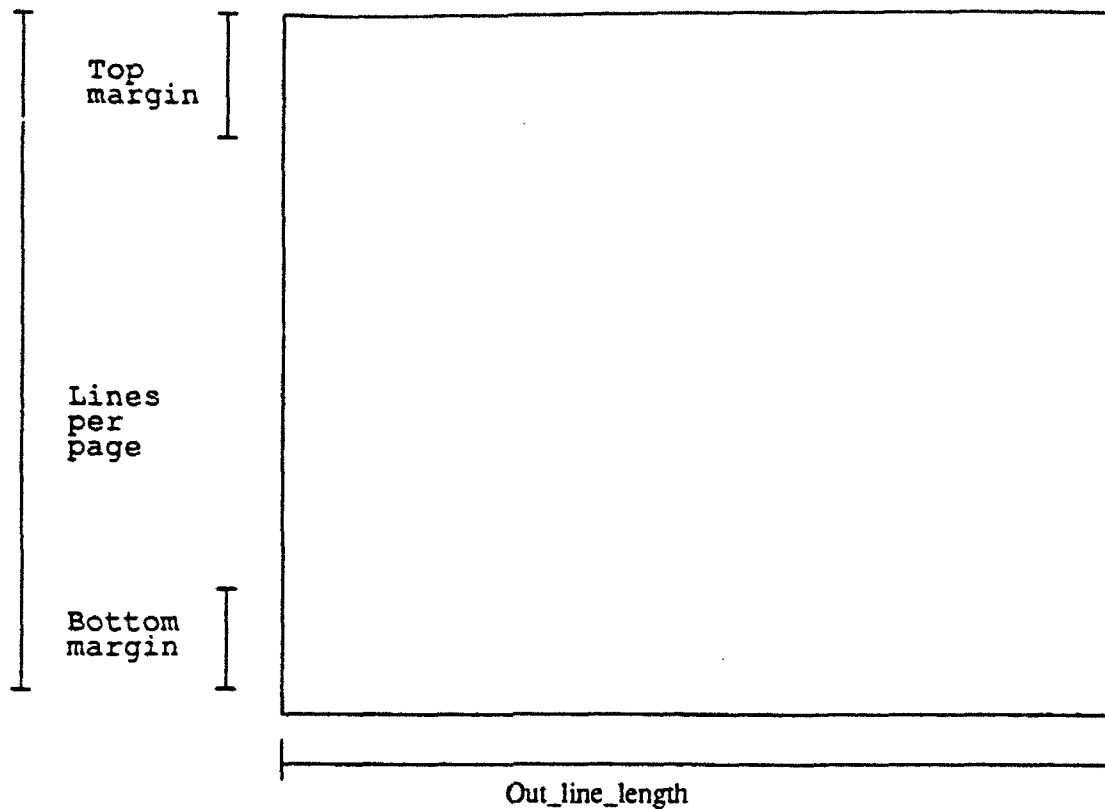


Figure 5-1 Page Layout

### 5.3 Compiler Output

The compiler may produce output in the list file, the diagnostic file, and the current output file. It also updates the program library if the compilation is successful. The present section describes the text output in the three files mentioned above. The updating of the program library is described in Section 5.4.

The compiler may produce the following text output:

- 1) A listing of the source text with embedded diagnostic messages is written on the list file, if the option -L is active.
- 2) A compilation summary is written on the list file, if -L is active.
- 3) A cross-reference listing is written on the list file, if -x is active and no severe or fatal errors have been detected during the compilation.
- 4) If there are any diagnostic messages, a diagnostic file containing the diagnostic messages is written.
- 5) Diagnostic messages other than warnings are written on the current output file.



### 5.3.1 List File

The name of the list file is identical to the name of the source file except that it has the file type ".lis". The file is located in the current (default) directory. If any such file exists prior to the compilation, the newest version of the file is deleted. If the user requests any listings by specifying the options -L or -x, a new list file is created.

The list file may include one or more of the following parts: a source listing, a cross-reference listing, and a compilation summary.

The parts of the list file are separated by page ejects. The contents of each part are described in the following sections.

The format of the output on the list file is controlled by the configuration file (see Section 5.2.2) and may therefore be controlled by the user.

#### 5.3.1.1 Source Listing

A source listing is an unmodified copy of the source text. The listing is divided into pages and each line is supplied with a line number.

The number of lines output in the source listing is governed by the occurrence of LIST pragmas and the number of objectionable lines.

- 1) Parts of the listing can be suppressed by the use of the LIST pragma.
- 2) A line containing a construct that caused a diagnostic message to be produced is printed even if it occurs at a point where the listing has been suppressed by a LIST pragma.

In a source listing a diagnostic message is placed immediately after the source line causing the message.

#### 5.3.1.2 Compilation Summary

At the end of a compilation, the compiler produces a summary that is output in the list file, if the option -L is active.

The summary contains information about:

- 1) The type and name of the compilation unit, and whether it has been compiled successfully or not.
- 2) The number of diagnostic messages produced for each class of severity (see Section 5.3.2.2).
- 3) Which options were active.



- 4) The full name of the source file.
- 5) The full name of the current sublibrary.
- 6) The number of source text lines.
- 7) The size of the code produced (specified in bytes).
- 8) Elapsed real time and elapsed CPU time.
- 9) A "Compilation terminated" message if the compilation unit was the last in the compilation or "Compilation of next unit initiated" otherwise.

### 5.3.1.3 Cross-Reference Listing

A cross-reference listing is an alphabetically sorted list of the identifiers, operators, and character literals of a compilation unit. The list has an entry for each entity declared and/or used in the unit, with a few exceptions stated below. Overloading is evidenced by the occurrence of multiple entries for the same identifier.

For instantiations of generic units, the visible declarations of the generic unit are included in the cross-reference listing as declared immediately after the instantiation. The visible declarations are the subprogram parameters for a generic subprogram and the declarations of the visible part of the package declaration for a generic package.

For type declarations, all implicitly declared operations are included in the cross-reference listing.

Cross-reference information will be produced for every constituent character literal for string literals.

The following are not included in the cross reference listing:

- 1) Pragma identifiers and pragma argument identifiers.
- 2) Numeric literals.
- 3) Record component identifiers and discriminant identifiers. For a selected name whose selector denotes a record component or a discriminant, only the prefix generates cross-reference information.
- 4) A parent unit name (following the keyword SEPARATE).

Each entry in the cross-reference listing contains:

- 1) The identifier with, at most, 15 characters. If the identifier exceeds 15 characters, a bar ("I") is written in the 16th position and the rest of the characters are not printed.
- 2) The place of the definition, i.e., a line number if the entity is declared in the current compilation unit, otherwise the name of the compilation unit in which the entity is

declared and the line number of the declaration.

- 3) The numbers of the lines in which the entity is used. An asterisk ("\*") after a line number indicates an assignment to a variable, initialization of a constant, assignments to functions, or user-defined operators by means of RETURN statements.

An example of a cross reference listing can be found in Appendix B.

### 5.3.2 Diagnostic File

The name of the diagnostic file is identical to the name of the source file except that it has the file type ".err". It is located in the current (default) directory. If any such file exists prior to the compilation, the newest version of the file is deleted. If any diagnostic messages are produced during the compilation a new diagnostic file is created.

The diagnostic file is a text file containing a list of diagnostic messages, each followed by a line showing the number of the line in the source text causing the message, and a blank line. There is no separation into pages and no headings. The file may be used by an interactive editor to show the diagnostic messages together with the erroneous source text.

An example of a diagnostic file can be found in Appendix B.

#### 5.3.2.1 Placement of Messages

The Ada compiler issues diagnostic messages in the diagnostic file. Diagnostics other than warnings also appear on the standard output. If a source text listing is required, the diagnostics are also found embedded in the list file (see Section 5.3.1).

In a source listing, a diagnostic message is placed immediately after the source line causing the message. Messages not related to any particular line are placed at the top of the listing. Every diagnostic message in the diagnostic file is followed by a line stating the line number of the erroneous line. The lines are ordered by increasing source line numbers. Line number 0 is assigned to messages not related to any particular line. On the current output file the messages appear in the order in which they are generated by the compiler.

#### 5.3.2.2 Classes of Messages

The diagnostic messages are classified according to their severity and the compiler action taken:

- |          |  |
|----------|--|
| Warning: | Reports a questionable construct or an error that does not influence the meaning of the program. Warnings do not hinder the generation of object code. |
| Example: | A warning will be issued for constructs for which the compiler detects will raise CONSTRAINT_ERROR at run time.  |



- Error:** Reports an illegal construct in the source program. Compilation continues, but no object code will be generated.
- Examples:** Most syntax errors; most static semantic errors.
- Severe:** Reports an error which causes the compilation to be terminated immediately. No object code is generated.
- Example:** A severe error message will be issued if a library unit mentioned by a WITH clause is not present in the current program library.
- Fatal:** Reports an error in the compiler system itself. Compilation is terminated immediately and no object code is produced. The user may be able to circumvent a fatal error by correcting the program or by replacing program constructs with alternatives. Please inform DDC-I about the occurrence of fatal errors.

The detection of more errors than allowed by the number specified by the `ERROR_LIMIT` parameter of the configuration file (see section 5.2.2) is considered a severe error.

### 5.3.2.3 Format and Content of Messages

For certain syntactically incorrect constructs, the diagnostic message consists of a pointer line and a text line. In other cases a diagnostic message consists of a text line only.

The pointer line contains a pointer (a carat symbol `^`) to the offending symbol or to an illegal character.

The text line contains the following information:

1) The diagnostic message identification "\*\*\*\*"

2) The message code `XY-Z` where

`X` is the message number

`Y` is the severity code, a letter showing the severity of the error:

W: warning

E: error

S: severe error

F: fatal error

`Z` is an integer which, together with the message number `X`, uniquely identifies the compiler location that generated the diagnostic message; `Z` is of importance mainly

to the compiler maintenance team -- it does not contain information of interest to the compiler user.

The message code (with the exception of the severity code) will be suppressed if the parameter `SUPPRESS_ERROR_NO` in the configuration file has the value `TRUE` (see section 5.2.2).

- 3) The message text; the text may include one context dependent field that contains the name of the offending symbol; if the name of the offending symbol is longer than 16 characters only the first 16 characters are shown.

#### 5.3.2.4 Examples of Diagnostic Messages:

\*\*\* 18W-3: Warning: Exception `CONSTRAINT_ERROR` will be raised here

\*\*\* 320E-2: Name `OBJ` does not denote a type

\*\*\* 535E-0: Expression in return statement missing

\*\*\* 1508S-0: Specification for this package body not present in the library

#### 5.3.3 Return Codes

The compiler sets the return code to the following values:

Error code:	Description:
0	Success, warnings
1	Fatal error
2	Fatal error
3	Severe error during argument interpretation
4	Errors during parameter interpretation
5	Fatal error detected during compilation
6	Severe error detected during compilation
7	Error detected during compilation

#### 5.4 Program Library

This section briefly describes how the Ada compiler changes the program library. For a more general description of the program library, the user is referred to Chapter 3.

The compiler is allowed to read from all sublibraries constituting the current program library, but only the current sublibrary may be changed.

#### **5.4.1 Correct Compilations**

In the following examples it is assumed that the compilation units are correctly compiled, i.e., that no errors are detected by the compiler.

##### **Compilation of a library unit which is a declaration**

If a declaration unit of the same name exists in the current sublibrary, it is deleted together with its body unit and possible subunits. A new declaration unit is inserted in the sublibrary, together with an empty body unit.

##### **Compilation of a library unit which is a subprogram body**

A subprogram body in a compilation unit is treated as a secondary unit if the current sublibrary contains a subprogram declaration or a generic subprogram declaration of the same name and this declaration unit is not invalid. In all other cases it will be treated as a library unit, i.e.:

- 1) When there is no library unit of that name
- 2) When there is an invalid declaration unit of that name
- 3) When there is a package declaration, generic package declaration, an instantiated package, or subprogram of that name

##### **Compilation of a library unit which is an instantiation**

A possible existing declaration unit of that name in the current sublibrary is deleted together with its body unit and possible subunits. A new declaration unit is inserted.

##### **Compilation of a secondary unit which is a library unit body**

The existing body is deleted from the sublibrary together with its possible subunits. A new body unit is inserted.

##### **Compilation of a secondary unit which is a subunit**

If the subunit exists in the sublibrary it is deleted together with its possible subunits. A new subunit is inserted.

#### **5.4.2 Incorrect Compilations**

If the compiler detects an error in a compilation unit, the program library will remain unchanged.

Note that if a file consists of several compilation units and an error is detected in any of these compilation units, the program library will not be updated for any of the compilation units.

## 5.5 Instantiation of Generic Units

This section describes the order of compilation for generic units and situations in which errors will be generated deriving instantiation of a generic unit.

### 5.5.1 Order of Compilation

When instantiating a generic unit, it is required that the entire unit, including body and possible subunits, be compiled before the first instantiation. This is in accordance with the ARM Chapter 10.3 (1).

### 5.5.2 Generic Formal Private Types

This section describes the treatment of a generic unit with a generic formal private type, where there is some construct in the generic unit that requires that the corresponding actual type must be constrained if it is an array type or a type with discriminants, and there exists instantiations with such an unconstrained type (see ARM, Section 12.3.2(4)). This is considered an illegal combination. In some cases the error is detected when the instantiation is compiled, in other cases when a constraint-requiring construct of the generic unit is compiled:

- 1) If the instantiation appears in a later compilation unit than the first constraint-requiring construct of the generic unit, the error is associated with the instantiation which is rejected by the compiler.
- 2) If the instantiation appears in the same compilation unit as the first constraint-requiring construction of the generic unit, there are two possibilities:
  - a) If there is a constraint-requiring construction of the generic unit after the instantiation, an error message appears with the instantiation.
  - b) If the instantiation appears after all constraint requiring constructs of the generic unit in that compilation unit, an error message appears with the constraint-requiring construct, but will refer to the illegal instantiation.
- 3) The instantiation appears in an earlier compilation unit than the first constraint-requiring construction of the generic unit, which in that case will appear in the generic body or a subunit. If the instantiation has been accepted, the instantiation will correspond to the generic declaration only, and not include the body. Nevertheless, if the generic unit and the instantiation are located in the same sublibrary, then the compiler will consider it an error. An error message will be issued with the constraint-requiring construct and will refer to the illegal instantiation. The unit containing the instantiation is not changed, however, and will not be marked as invalid.



## 5.6 Uninitialized Variables

Use of uninitialized variables is not flagged by the compiler. The effect of a program that refers to the value of an uninitialized variable is undefined. A cross-reference listing may help to find uninitialized variables.

## 5.7 Related Reference Topics

The following topics related to the compiler are described in detail in the Compiler System Reference Manual:

- 1) Memory Organization
- 2) Data Representation
- 3) Storage Layout
- 4) Interprocedure Protocol
- 5) Exception Handling



## LINKER OPTIONS

The linker options of this Ada implementation, as described in this Appendix, are provided by the customer. Unless specifically noted otherwise, references in this appendix are to linker documentation and not to this report.

The DACS linker must be executed to create an executable program. Linking is a two stage process that includes an Ada link using the compilation units in the Ada program library, and a target link to integrate the application code, run-time code, and any additional configuration code developed by the user. The linker performs these two stages with a single command, providing options for controlling both the Ada and target link processes. The executable file produced by the linker is directly executable.

### 6.1 Linker Features

The DACS Sun SPARC/SunOS Native Linker provides many features that improve the performance and usability of the entire Compiler System. These are summarized below:

- |                   |   |
|-------------------|---|
| Selective Linking | - Eliminating unused subprograms in the executable program.   |
| Flexible Linking  | - Managing the information generated by the Ada linker and the execution of the target link is completely controlled by the user. |
| RTS Configuration | - Many aspects of the Run-Time System can be configured via options to the Linker.  |

### 6.2 The Linking Process

The linking process can be viewed as two consecutive phases. Both are automatically carried out when issuing the link command al.

The first phase constitutes the Ada link phase and the second constitutes the target link phase.

The Ada link phase:

- 1) Retrieves the required Ada object modules from the program library.
- 2) Determines an elaboration order for all Ada units.
- 3) Creates a module containing the User-Configurable Data (UCD) from the specified configuration options to the linker.
- 4) Instantiates the shell script template command file that carries out the native link process to create an A.OUT module. If the keep option (section 6.3.3.4) is NOT specified (default), the above shell script is executed. Otherwise the linking process is halted at this point.

When option keep (section 6.3.3.4) is specified, all temporary files are retrieved for inspection or modification. The target linker is invoked by executing the shell script.

**\*\*\* NOTE \*\*\***

Several simultaneous links of the same program should not be performed in the same directory.

The link process is controlled by a variety of parameters, options, and environment variable. The following diagram illustrates the linking process:

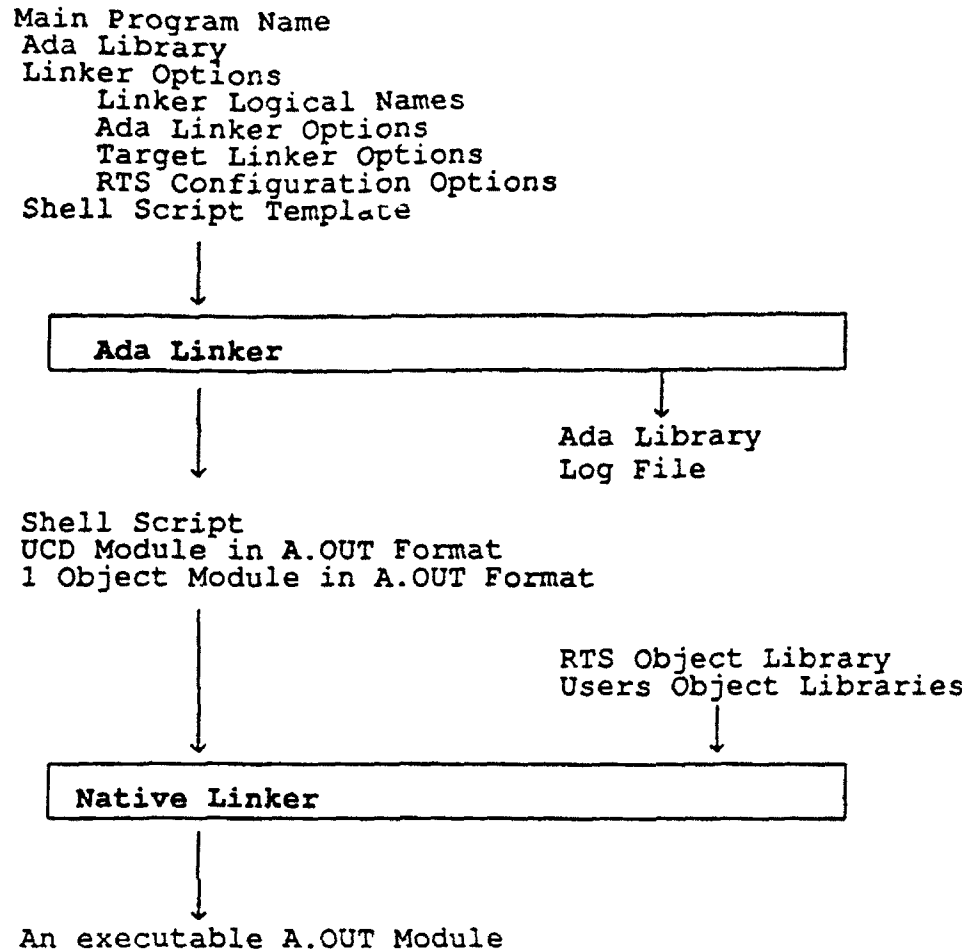


Figure 6-1  
The Linking Process

### 6.3 Invocation Command

Enter the following command to invoke the linker:

**al {<option>} <unit-name>**

The options and parameters supported by the linker are described in the following sections.

### 6.3.1 Parameter

<unit-name>

This parameter is required and indicates the main program. The <unit\_name> must be a library unit in the current program library, but not necessarily of the current sublibrary.

Note, that a main program must be a procedure without parameters, and that <unit-name> is the identifier of the procedure, not a file specification. The main procedure is not checked for parameters, but the execution of a program with a main procedure with parameters is undefined.

### 6.3.2 Summary of Options

This section briefly describes all options supported by the Ada linker.

Option	DESCRIPTION	REFERENCE
-debug	Specifies that the executable file is to be used by the DDC-I Symbolic Ada Debugger.	6.3.3.1
-noexceptions	No spellings of user exceptions will be included in the executable file.	6.3.3.2
-executable <file-name>	Specifies the name of the executable file.	6.3.3.3
-keep	Performs Ada link only, and keeps object files.	6.3.3.4
-library <library-name>	Specifies the library to be used in the link.	6.3.3.5
-log <file-name>	Specifies creation of a log file.	6.3.3.6
-main_stack_size <natural>	Default stack size for main program.	6.3.3.7
-period <duration>	Timer resolution.	6.3.3.8
-priority <positive>	Default task priority.	6.3.3.9
-profile	Enable profiling of the executable program.	6.3.3.10
-selective	Enables selective linking.	6.3.3.11
-statistics	Display statistics.	6.3.3.12
-target_options <string>	Specifies a string which is passed to the template without interpretation.	6.3.3.13

<b>-task_stack_size</b> <natural>	Default stack size for all tasks.	6.3.3.14
<b>-tasks</b> <natural>	Maximum number of tasks.	6.3.3.15
<b>-template_file</b> <template-name>	Specifies template file for the target link.	6.3.3.16
<b>-notimer</b>	Disable timer setup in the executable program.	6.3.3.17
<b>-time_slice</b> <duration>	Task time slicing enabled and time slice value.	6.3.3.18
<b>-traceback_mode</b> <keyword>	Enables traceback when a program has an unhandled exception.	6.3.3.19
<b>-usr_library</b> <file-name>	Libraries or object modules to include in link.	6.3.3.20
<b>-warnings</b>	Specifies that warnings are displayed.	6.3.3.21

---

All options must be entered in lowercase, and may be abbreviated to the minimal unique substring (e.g. "-d" is sufficient to denote "-debug").

### 6.3.3 Ada Link Options

This section describes in detail all Ada link options, including default settings.

#### 6.3.3.1 DEBUG

Syntax:

**-debug**

This option specifies that information for the DDC-I Symbolic Ada Debugger is to be generated. Please note that no extra information is included in the code or data generated.

#### 6.3.3.2 NOEXCEPTION TABLES

Syntax:

**-noexceptions**

This option specifies that no table containing the spellings of user-defined exceptions should be included in the executable file. Without spellings for user-defined exceptions a stack trace for an unhandled user-defined exception will appear with a reference to the unit number in which the exception is defined and an exception number within the unit.

### 6.3.3.3 EXECUTABLE FILENAME

Syntax:

**-executable <file-name>**

Specifies the name of the output module. Default is the name of the main program.

Examples:

```
$ al p
```

- Links the subprogram P and stores the executable program in the file p

```
$ al -exec my_exe_dir/main p
```

- Links the subprogram P and stores the executable program in the file main in the directory my\_exe\_dir.

### 6.3.3.4 KEEP

Syntax:

**-keep**

This option controls whether or not the native link phase is executed, i.e., whether or not control is passed to the flexible linker template file, and the intermediate link files are preserved. The option specifies to stop linking before the native link and keep the intermediate link files.

### 6.3.3.5 LIBRARY

Syntax:

**-library <library-name>**

This option defines the program library that contains the <unit-name>. If <library-name> is not specified, the default library specified by the environment variable ADA\_LIBRARY will be selected.

### 6.3.3.6 LOG

Syntax:

**-log <file-name>**

The option specifies if a log file will be produced from the front end linker. As default, no log file is produced. The log file contains extensive information on the results of the link. The file

includes:

- 1) An elaboration order list with an entry for each unit included, showing the order in which the units will be elaborated.
- 2) All options and their actual values.
- 3) The full name of the program library (the current sublibrary and its ancestor sublibraries).

### 6.3.3.7 MAIN STACK SIZE

Syntax:

`-main_stack_size <natural>` (Default is 4096)

The main stack size option specifies the main program stack size *N* in 32 bit words. The range of this parameter is limited by physical memory size. The range of main stack size is from 0 to 2,147,483,647

#### Configurable Data

The Ada linker generates the following data structures:

UCD\$MP\_Stack\_Size

*N*

UCD\$MP\_Stack

Lowest addr  
of MP stack

UCD\$MP\_Stack\_Start

Highest addr  
of MP stack

Example:

```
$ a1 -main 1024 p
```

- Link the program *p* with a stack of 4096 bytes.



### 6.3.3.8 PERIOD

Syntax:

**-period <decimal-number>** (Default is 0.05)

The period option specifies the resolution of calls to the Run-Time System routine RTS\$TIMER. The number specifies the number of seconds between two successive calls to RTS\$TIMER. The number must be within the range duration'small to 2.0

#### Configurable Data

The Ada Linker generates the following 32 bit integer:

UCD\$Timer

absolute integer

### 6.3.3.9 PRIORITY

Syntax:

**-priority <integer>** (Default is 16)

The priority option specifies the default priority N for task execution. The main program will run at this priority, as well as tasks which have had no priority level defined via pragma PRIORITY. The range of priorities is from 1 to 32.

#### Configurable Data

The Ada Linker generates the following constant data:

UCD\$Priority

N

Example:

**\$ al -priority 8 p**

- Link the subprogram P which has the main program and tasks running at default priority 8.



### 6.3.3.10 PROFILE

Syntax:

**-profile**

This option specifies that the executable program shall allocate memory for profiling information and be linked with a profiling library. The option is used together with the DDC-I Profiler.

### 6.3.3.11 SELECTIVE LINKING

Syntax:

**-selective**

Specifies that only those subprograms from each compilation which are referred to from other subprograms i.e. only those subprograms which actually are in the program are linked within the program, and thereby minimizing the size of the executable program.

### 6.3.3.12 STATISTICS

Syntax:

**-statistics**

Specifies that short statistics shall be displayed about how many compilation units included in the program and how many dependencies they have.

### 6.3.3.13 TARGET OPTIONS

Syntax:

**-target\_options <string>**

This option allows the user to specify target options which is passed to the native linker (SunOS: ld) without interpretation. It therefore allows the user to specify other options than those mentioned in this section.

Example:

```
$ al -target "-L/usr/local/lib" p
```

- Links the subprogram P and substitutes the macro template %target\_options% by the string "-L/usr/local/lib".

This option allows any string to be propagated to the resulting command file via the macro template %TARGET\_OPTIONS%.

### 6.3.3.14 TASK STACK SIZE

Syntax:

`-task_stack_size <natural>` (Default is 1024)

This option sets the default storage size N in 32 bit words for stacks of all tasks. This value can be overridden with a representation clause.

#### Configurable Data

The Ada Linker generates the following data structure:

UCD\$Task\_Stack\_Size

N

### 6.3.3.15 TASKS

Syntax:

`-tasks <natural>` (default is 128)

This option specifies the maximum number of tasks allowed by the RTS. If specified, N must be greater than or equal to zero.

#### Configurable Data

For the tasks option, the linker generates the following configurable data:

UCD\$Max\_Tasks

N

UCD\$TCBs

N Task  
Control  
Blocks  
(TCBS)

Example:

```
$ al -tasks 3 p
```

- Link the program p, which has at most 3 tasks, including the main program.



### 6.3.3.16 TEMPLATE

Syntax:

**-template\_file <file-name>**

This option specifies a template file to use for the native link. The default is to use the file named `Ada_template.txt` placed in the same directory as the Ada linker. See section 6.5 for an explanation of the template file and the flexible linker.

### 6.3.3.17 NOTIMER

Syntax:

**-notimer**

This option disables timer setup in the executable program. Specifies that the Ada timer is not set up. This causes that delays waits forever, and that `-time_slice` will not function. This option is usefull when debugging programs using dbx, and kernel calls are not interrupted. The option is also usefull when using the `-profile` option, because the profile timer has a higher resolution than the Ada timer, which gives a more detailed profiling information.

### 6.3.3.18 TIME SLICE

Syntax:

**-time\_slice <decimal-number>**

The time slice option specifies the time slicing period for tasks.

If specified, it is a decimal number of seconds representing the default time slice to be used. If not specified, there will be no time slicing. The number must be in the range `Duration'Small..2.0` and must be greater than or equal to the distance between two successive calls to `RTS$TIMER`.

Time slicing only applies to tasks running at equal priority. Because the RTS is a preemptive priority scheduler, the highest priority task will always run before any lower priority task. Only when two or more tasks are running at the same priority is time slicing applied to each task.

Time slicing is not applicable unless tasking is being used. This means that the `tasks` option must be set to at least 2 for time slice to be effective.

### Configurable Data

The Ada Linker generates the following data:

UCD\$Time\_Slice

absolute integer

- = 0 -> No time slicing
- /= 0 -> The length of a time slice

The number of timer ticks (UCD\$Time\_Slice) constituting a time\_slice is computed as  $\lceil \text{TimeSlice} / \text{Period} \rceil$

Example:

```
$ a1 -time 0.125 p
```

- Specifies tasks of equal priority to be time sliced each eighth of a second.

### 6.3.3.19 TRACEBACK MODE

Syntax:

**-traceback\_mode (NEVER | MAIN | ALWAYS) (default is MAIN)**

This option instructs the exception handler to produce a stack trace when a program terminates because of an unhandled exception. Disabling traceback (with NEVER) exclude traceback tables from the executable program. If NEVER is specified, the RTS variable UCD\$TRACE will be set to 0 and no trace will be produced if the program terminates with an unhandled exception. If MAIN is specified a trace will be produced if the main program terminates with an unhandled exception. The RTS variable UCD\$TRACE will be set to 1. If the ALWAYS is specified the RTS variable UCD\$TRACE will be set to 2 and a trace will be produced if either the main program or a task terminate with an unhandled exception.

#### Configurable Data

UCD\$Trace

absolute integer

- = 0 -> Trace disabled
- = 1 -> Trace enabled for main program
- = 2 -> Trace enabled for main program and tasks



### 6.3.3.20 USER LIBRARY

Syntax:

**-usr\_library <file-name>**

The user library option is intended for the specification of libraries or object files which should contain the users own object code.

The user library option is also intended to specify libraries of routines referenced from the Ada program via pragma INTERFACE.

### 6.3.3.21 WARNINGS

Syntax:

**-warnings**

This option specifies that warnings are displayed if detected by the linker, otherwise they are suppressed. Warnings can be generated when conflicts between target program attributes and the specified options are found and when a package has an inconsistent body.

## 6.4 Linker Output

This chapter describes the results of the linking process.

### 6.4.1 Executable File

Using the default options and the template provided with the system the linking process will result in an executable file which is ready for execution. This file is named after the main program:

**<main\_program\_name>**

### 6.4.2 Diagnostic Messages

Diagnostic messages from the Ada Linker are output to the current output file. The messages are output in the order they are generated by the linker.

The linker may issue two kinds of diagnostic messages: warnings and severe errors.

#### 6.4.2.1 Warnings

A warning reports something which does not prevent a successful linking, but which might be an

error. A warning is issued if there is something wrong with the body unit of a program unit which formally does not need a body unit, e.g. if the body unit is invalid or if there is no object code container for the body unit.

### 6.4.2.2 Severe Errors

A severe error message reports an error which prevents a successful linking. Any inconsistency detected by the linker will, for instance, cause a severe error message, e.g. if some required unit does not exist in the library or if some time stamps do not agree.

A unit not marked as invalid in the program library may be reported as being invalid by the linker if there is something wrong with the unit itself or with some of the units it depends on.

### 6.4.2.3 Return Codes

The linker set the return code to the following values:

Error code	Description
0	Success, warnings
1	Errors
2	Fatal Error

## 6.5 Flexible Linker

The DACS Ada Linker is referred to as a flexible linker because it has been designed to be very flexible in the way it interfaces to target tools such as assemblers, librarians, and linkers. The flexible linker can produce a target link in any manner that the user desires, i.e. the linker adapts to each user's needs in a simple and straightforward manner.

The user control of the invocation of the native linker (ld) is obtained by means of a shell script template. The template contains the commands necessary to execute the native link and is parameterized by means of macros which are expanded by the Flexible Linker prior to execution. The user is allowed to modify the template to fit special purposes regarding invocation of the native linker and any desired postprocessing.

### 6.5.1 Intermediate Link Files

The object modules for the user-configurable data and for the elaboration calling code are generated directly by the linker, i.e., no assembler is needed. Also, the linker template file is instantiated and executed to control the native link. The intermediate files generated as a result of the Ada link are shown below:

<main\_program>\_link      The expanded template file. This is normally a shell script which



invokes the target linker.

<code>&lt;main_program&gt;_ucd.o</code>	The object code generated for RTS configuration.
<code>&lt;main_program&gt;.o</code>	The A.OUT Ada object module which has been extracted and merged from the program library.

## 6.5.2 Template File

The template file will usually contain shell statements that can be executed to perform some action as the result of an Ada link, usually a native link. The template file is input to the linker, which expands predefined macros in the template file. The macro expansions are simply literal substitutions of file names and other information (compilation unit numbers, target link options, etc.) generated or otherwise obtained by the linker.

The linker copies the template file to a new file and expands the macros in the new file. This new file is referred to as the expanded template. The expanded template will usually contain shell statements and a native link invocation in the format and syntax required by the user, which can then be executed to complete the native link. However, the template need not be a shell script; it can be of any format desired by the users.

A template file does not specify in any way WHAT information the linker generates; it only specifies what and where names are placed in the shell script. Directives to the linker about what to generate and how to generate it (e.g. use tasking, object module format, etc.) are always specified exclusively by options on the command line, or are otherwise hardcoded in the linker (e.g., names and content of elaboration and UCD object files).

The linker in no way verifies or validates the contents of the input template file. This is because the template file is completely the user's responsibility, i.e., it may in fact be something else than a shell script.

### 6.5.2.1 Macro Delimiters

The macros contained in the template file are delimited by the special character "%". This character has been chosen because it does not conflict with SunOS wildcard characters, shell script comments or allowable file name characters.

The string and special characters surrounding each macro will be replaced by the appropriate strings generated by the linker. For example, if the main program name was TEST, then %MAIN\_PROGRAM% would be replaced by TEST.

### 6.5.2.2 Macro Restrictions

In general, there are no restrictions regarding the placement of macros, i.e., multiple macros can occur on the same line, however,

- 1) Blocks cannot be nested.
- 2 Block start and block end macros must be paired correctly.



- 3) Text that appears on the same line as a block delimiting macro will be ignored (removed).

The macros that are supported are described in the next section. For each macro, the syntax, semantics, and error conditions are described.

### 6.5.2.3 Expanding the Macros

The linker template file is just that, a template. As such, the template file itself always remains unchanged by the linker. The linker will create a copy of the template in the current directory and expand the macros into the copied file. This copied file becomes the expanded template.

Due to the temporary nature of the expanded file (since it is normally created, executed, and deleted), the file is named by the linker. However, the user does have control over the naming and execution of the expanded template.

The default templates delivered with the compiler system reside in the DACS directory, but users can create other templates and use option -N (see section 6.3.3.16) to address the appropriate template file.

### 6.5.2.4 Executing the Native Link

The native link is performed by executing the expanded template shell script. The default case is for the linker to automatically execute this file after it has made all the macro expansions and then to delete the file.

The keep option (see section 6.3.3.4) can be used to stop the link process short of performing a target link. This will cause the template to be expanded and left in the default directory, but not executed.

### 6.5.2.5 Errors in the Template File

Macros that will cause an error condition to occur are indicated in the section describing each macro. Also, the presence of some macros are simply ignored and no error is generated. These are also described in the subsequent sections on macros.

### 6.5.2.6 Unrecognized Macros

Unrecognized macros will be flagged as errors. Unrecognized macros, of course, include misspellings and the inclusion of any additional characters within the macro delimiters of an otherwise acceptable macro.



### 6.5.2.7 Macro Blocks

Some macros will cause an error to occur because one component of a macro pair is missing. For example, the repeat macros come in pairs to indicate the beginning and end of a repeat block. Other macros are undefined unless they appear within one of the macro pairs, which will cause an error.

### 6.5.3 Template File Macros

This section describes each of the template file macros supported by the linker.

MACRO	REFERENCE
%COMPILER_DIR%	6.5.3.1
%MAIN_PROGRAM_NAME%	6.5.3.3
%OBJECT_FILE%	6.5.3.2
%OUTFILE%	6.5.3.14
%NATIVE_LIBRARY%	6.5.3.7
%PID%	6.5.3.15
%RTS_LIBRARY%	6.5.3.8
%REPEAT_FOR_ALL_SEARCHLIBS%	6.5.3.9
%SEARCHLIB%	6.5.3.10
%END_REPEAT_FOR_ALL_SEARCHLIBS%	6.5.3.11
%START_UP%	6.5.3.12
%REPEAT_FOR_ALL_UNITS%	6.5.3.4
%UNIT_NUMBER%	6.5.3.5
%END_REPEAT_FOR_ALL_UNITS%	6.5.3.6
%TARGET_OPTIONS%	6.5.3.13

**6.5.3.1 Compiler Installation Directory**

Syntax: %COMPILER\_DIR%

Semantics:

This macro string will be replaced with the full pathname of the directory where the DACS compiler is installed. The name is generated by DDC-I Ada Linker. The macro can be used to generate complete pathnames for additional files to be included as part of the link.

Errors: None

**6.5.3.2 Object File Name**

Syntax: %OBJECT\_FILE%

Semantics:

This macro string will be replaced with the name of the object module containing the object code of the Ada programs. The name is generated by DDC-I Ada Linker. The name includes file name and extension only, i.e. no directory path. Furthermore, the name of the file is linker-defined and is guaranteed to be unique within the Ada program library.

Errors: None

**6.5.3.3 Main Program Name**

Syntax: %MAIN\_PROGRAM\_NAME%

Semantics:

This string will be replaced by the Ada name of the main program. This macro can be used as one component in the name of the relocatable link object file.

Errors: None

**6.5.3.4 Start Repeat Unit Block**

Syntax: %REPEAT\_FOR\_ALL\_UNITS%

Semantics:

This macro informs the linker that all text encountered from the next statement until the END\_REPEAT\_FOR\_ALL\_UNITS macro will be duplicated for all program units that make up the program. See the UNIT\_OBJECT and UNIT\_NUMBER macros.

The text within the repeat block will be duplicated exactly as specified, except for any macro



expansions within the repeat block. The line that contains this macro will be removed from the file.

**Errors:**

If there is not a one-to-one correspondence between this macro and an `END_REPEAT_FOR_ALL_UNITS` macro.

### 6.5.3.5 Unit Number

**Syntax:** `%UNIT_NUMBER%`

**Semantics:**

Each compilation unit is assigned a unit number by the compiler. This macro can be used to obtain the unit numbers of all units that make up the program.

This macro should be used in conjunction with the `REPEAT_FOR_ALL_UNITS` macro described earlier. When used within a repeat block, each iteration of the loop will cause the unit number of the next program unit that makes up the program to be output to the expanded template.

**Errors:**

If this macro appears outside a `REPEAT_FOR_ALL_UNITS` block.

### 6.5.3.6 End Repeat Unit Block

**Syntax:** `%END_REPEAT_FOR_ALL_UNITS%`

**Semantics:**

This macro signals the end of a repeat block started by the `REPEAT_FOR_ALL_UNITS` macro. The entire line containing this macro will be removed, therefore, the macro string itself should appear on a line by itself within the template file.

**Errors:**

This macro does not appear after a `REPEAT_FOR_ALL_UNITS` macro somewhere within the template file.

If there is not a one-to-one correspondence between this macro and a `REPEAT_FOR_ALL_UNITS` macro.

**6.5.3.7 Native Library Name**

Syntax: `%NATIVE_LIBRARY%`

Semantics:

This macro string will be replaced with the name of the native system service library specified indirectly via the linker option profile.

Errors: None

**6.5.3.8 RTS Library Name**

Syntax: `%RTS_LIBRARY%`

Semantics:

This macro string will be replaced with the name of the run-time system library specified indirectly via the linker options noüimer and profile.

Errors: None

**6.5.3.9 Start Repeat Search Libs Block**

Syntax: `%REPEAT_FOR_ALL_SEARCHLIBS%`

Semantics:

This macro informs the linker that all text from the next statement until the `END_REPEAT_FOR_ALL_SEARCHLIBS` macro is encountered will be duplicated for all libraries (or object files) specified as alternate search libraries on the linker command line. The order in which the libraries are processed is identical to that specified on the command line. See the `SEARCHLIB` macro for more information.

The text within the repeat block will be duplicated exactly as specified, except for any macro expansions within the repeat block. The macro string itself will be removed from the file.

If the `usr_library` option (see section 6.3.3.20) is not used on the command line, this macro and the block which it encloses is ignored, i.e., no error will be generated and no statements within the repeat block will be copied to the expanded template file.

Errors:

If there is not a one-to-one correspondence between this macro and a `END_REPEAT_FOR_ALL_SEARCHLIBS` macro.



#### 6.5.3.10 Search Libraries

Syntax: `%SEARCHLIB%`

Semantics:

This macro should be used in conjunction with the `REPEAT_FOR_ALL_SEARCHLIBS` macro described earlier. When used within a repeat block, each iteration of the loop will cause the search library name of the next search library from the linker command line to be output to the expanded template (see option `usr_library` section 6.3.3.20).

Errors:

If this macro occurs outside a `searchlib` repeat block.

#### 6.5.3.11 End Repeat Search Libs Block

Syntax: `%END_REPEAT_FOR_ALL_SEARCHLIBS%`

Semantics:

This macro signals the end of a repeat block started by the `REPEAT_FOR_ALL_SEARCHLIBS` macro. The entire line containing this macro will be removed, therefore, the macro should appear on a line by itself within the template file. If the `usr_library` option (see section 6.3.3.20) is not used on the command line, the entire `searchlib` repeat block will be removed with no action and no error will be generated.

Errors:

If this macro does not appear after a `REPEAT_FOR_ALL_SEARCHLIBS` macro somewhere within the template file and it is not being ignored for reasons cited above.

If there is not a one-to-one correspondence between this macro and a `REPEAT_FOR_ALL_SEARCHLIBS` macro.

#### 6.5.3.12 Start-up Module Name

Syntax: `%START_UP%`

Semantics:

This macro string will be replaced with the name of the native start-up module specified indirectly via the linker option profile.

Errors: None

### 6.5.3.13 Target Options

Syntax: %TARGET\_OPTIONS%

Semantics:

This macro will be replaced literally with the target option string specified on the command line. If double quotes are used to bracket the option string on the command line, they will be removed from the string before it is placed in the expanded template. If no options are specified, this macro is ignored, it will be removed with no action, and no error is generated.

Errors: None

### 6.5.3.14 Outfile

Syntax: %OUTFILE%

Semantics:

This macro will be replaced literally with the executable option string specified on the command line. If double quotes are used to bracket the option string on the command line, they will be removed from the string before it is placed in the expanded template. If no options are specified, this macro is replaced with the name of the main unit (from the command line).

Errors: None

### 6.5.3.15 Process Identification

Syntax: %PID%

Semantics:

This macro will be replaced with the process identification of the linking process. This can be used to create unique file names.

Errors: None

## 6.5.4 Example Input Template File

This section illustrates a sample input template to the Flexible Linker for DACS Sun SPARC/SunOS. DDC-I supplies a default template in its standard compiler distribution system. The user can choose to use the default template unaltered, modify it, or write his own as necessary. The file shown here is the default template file Ada\_template.txt:

```
ld %TARGET_OPTIONS%      \
    -dc                   \
    -dp                   \
```



```

-Bstatic \
-e start \
%START_UP% \
%OBJECT_FILE% \
%CONFIG_DATA_OBJECT% \
%REPEAT_FOR_ALL_SEARCHLIBS% \
%SEARCHLIB% \
%END_REPEAT_FOR_ALL_SEARCHLIBS% \
-L/usr/lib \
-L%COMPILER_DIR% \
-l%RTS_LIBRARY% \
-l%NATIVE_LIBRARY% \
%OUTFILE%

# Macro symbols not used in example template:

# MAIN_PROGRAM_NAME %MAIN_PROGRAM_NAME%
%REPEAT_FOR_ALL_UNITS%
# UNIT_NUMBER %UNIT_NUMBER%
%END_REPEAT_FOR_ALL_UNITS%
# PID %PID%

/bin/rm %OBJECT_FILE%
/bin/rm %CONFIG_DATA_OBJECT%
/bin/rm $0

```

### 6.5.5 Example Expanded Template File

This section illustrates how the sample input template of the previous section would look after it was expanded by the Flexible Linker.

The linker command line to create this expanded template was:

```
$ al p
```

The flexible linker will then expand the template and the resulting command file will be:

```

ld \
-dc \
-dp \
-Bstatic \
-e start \
/usr/lib/crt0.o \
example_2.o \
example_2_ucl.o \
-L/usr/lib \
-L/usr/dacs \
-lrts \
-lc \
-o example_2

# Macro symbols not used in example template:

# MAIN_PROGRAM_NAME EXAMPLE_2

```



```
# UNIT_NUMBER      00000
# UNIT_NUMBER      04098
# UNIT_NUMBER      04099
# PID              5946
```

```
/bin/rm example_2.o
/bin/rm example_2_ucl.o
/bin/rm $0
```

## 6.6 Related Reference Topics

The following topics related to the linker are described in detail in the Compiler System Reference Manual:

- 1) Code and Table Layout
- 2) Memory Organization

## APPENDIX C

### APPENDIX F OF THE Ada STANDARD

The only allowed implementation dependencies correspond to implementation-dependent pragmas, to certain machine-dependent conventions as mentioned in Chapter 13 of the Ada Standard, and to certain allowed restrictions on representation clauses. The implementation-dependent characteristics of this Ada implementation, as described in this Appendix, are provided by the customer. Unless specifically noted otherwise, references in this Appendix are to compiler documentation and not to this report. Implementation-specific portions of the package STANDARD, which are not a part of Appendix F, are:

package STANDARD is

type SHORT\_INTEGER is range -32\_768 .. 32\_767;

type INTEGER is range -2\_147\_483\_648 .. 2\_147\_483\_647;

type FLOAT is digits 6

range -16#0.FFFF\_FF#E32 .. 16#0.FFFF\_FF#E32;

type LONG\_FLOAT is digits 15

range -16#0.FFFF\_FFFF\_FFFF\_F8#E256 .. 16#0.FFFF\_FFFF\_FFFF\_F8#E256;

type DURATION is delta 2#1.0#E-14 range -131\_072.0 .. 131\_071.0;

end STANDARD;



## APP. F - IMPLEMENTATION DEPENDENT CHARACTERISTICS

---

This appendix describes the implementation-dependent characteristics of DACS Sun SPARC/SunOS as required in Appendix F of the Ada Reference Manual (ANSI/MIL-STD-1815A).

### F.1 Implementation-Dependent Pragmas

This section describes all implementation defined pragmas.

#### F.1.1 Pragma `INTERFACE_SPELLING`

This pragma allows an Ada program to call a non-Ada program whose name contains characters that would be an invalid Ada subprogram identifier. This pragma must be used in conjunction with pragma `INTERFACE`, i.e., pragma `INTERFACE` must be specified for the non-Ada subprogram name prior to using pragma `INTERFACE_SPELLING`.

##### F.1.1.1 Format

The pragma has the format:

```
pragma INTERFACE_SPELLING (subprogram name, string literal);
```

where the subprogram name is that of one previously given in pragma `INTERFACE` and the string literal is the exact spelling of the interfaced subprogram in its native language. This pragma is only required when the subprogram name contains invalid characters for Ada identifiers.

##### F.1.1.2 Example

```
function ASSEMBLY_MODULE_NAME return INTEGER;

pragma INTERFACE (AS, ASSEMBLY_MODULE_NAME);
pragma INTERFACE_SPELLING (ASSEMBLY_MODULE_NAME,
                           "Illegal$Ada_Name");
```

#### F.1.2 Pragma `EXTERNAL_NAME`

This pragma allows an Ada program to export the name of an Ada subprogram so that it can be called from a non-Ada component.

### F.1.2.1 Format

The pragma has the format:

```
pragma EXTERNAL_NAME (subprogram name, string literal)
```

where subprogram name is the Ada name of the subprograms to be exported and string literal is the name used in the non-Ada component calling the Ada subprogram.

### F.1.2.2 Example

The current version of the compiler system does not support interrupt handling using address specifications. It is possible to do it using the pragma `External_Name` though. This example shows how to export the name of an Ada subprogram to be called from the trap handler of the UCC.

Please note that the preferred way of invoking Ada code from the interrupt handler is via a fast interrupt handler, see Chapter F.10.3 (Fast Interrupt Handler).

Please also note that for the example to work, the body of that Ada procedure may not call any tasking construct (delay, entry call or task creation). Also, the subprogram must be declared at the library level, i.e. it cannot be enclosed in another subprogram, task or package.

This is the Ada procedure to be called:

```
procedure interrupt is
```

```
    pragma external_name(interrupt,"Ada$Interrupt");
```

```
begin
```

```
    intdata.count:= intdata.count + 1;  -- Update global variable
end interrupt;
```

and this is how to call it from the trap handler of the UCC. The call is inserted just after the call to `RTS$Timer` routine:

```
call RTS$Timer
    nop
```

```
.extern TK$Current_Task
.extern Ada$Interrupt
```

```
mov  r16,r6                      // Save context pointer
mov  r2,r7                      // Save stack pointer
```

```
ld.l  ctxt_r2(r16),r2
ld.l  TK$Current_Task,r4
and   0xFFFFFFFF0,r2,r2
```

```

call Ada$Interrupt
  nop

mov  r6,r16           // Restore context pointer
mov  r7,r2            // Restore stack pointer

```

## F.2 Implementation-Dependent Attributes

No implementation-dependent attributes are defined.

## F.3 Package SYSTEM

The package SYSTEM is described in ARM 13.4.

```

package SYSTEM is

  type ADDRESS is new INTEGER;
  type NAME is (DACS_SPARC);

  SYSTEM_NAME      : constant NAME := DACS_SPARC;
  STORAGE_UNIT     : constant      := 8;
  MEMORY_SIZE      : constant      := 2048 * 1024;
  MIN_INT          : constant      := -2_147_483_648;
  MAX_INT          : constant      := 2_147_483_647;
  MAX_DIGITS       : constant      := 15;
  MAX_MANTISSA     : constant      := 31;
  FINE_DELTA       : constant      := 2#1.0#E-31;
  TICK             : constant      := 2#1.0#E-14;

  subtype PRIORITY is INTEGER range 1..31;
  type INTERFACE_LANGUAGE is (C, AS); -- implementation dependent

  -- Compiler system dependent types:

  subtype Integer_16 is short_integer;
  subtype Natural_16 is Integer_16 range 0..Integer_16'last;
  subtype Positive_16 is Integer_16 range 1..Integer_16'last;

  subtype Integer_32 is integer;
  subtype Natural_32 is Integer_32 range 0..Integer_32'last;
  subtype Positive_32 is Integer_32 range 0..Integer_32'last;

end SYSTEM;

```

## F.4 Representation Clauses

The representation clauses that are accepted are described below. Note that representation specifications can be given on derived types as well.

### F.4.1 Length Clause

Four kinds of length clauses are accepted.

#### Size specifications:

The size attribute for a type T is accepted in the following cases:

- If T is a discrete type then the specified size must be greater than or equal to the number of bits needed to represent a value of the type, and less than or equal to 32. Note that when the number of bits needed to hold any value of the type is calculated, the range is extended to include 0 if necessary, i.e. the range 3..4 cannot be represented in 1 bit, but needs 3 bits.
- If T is a fixed point type, then the specified size must be greater than or equal to the smallest number of bits needed to hold any value of the fixed point type, and less than 32 bits. Note that the Reference Manual permits a representation, where the lower bound and the upper bound is not representable in the type. Thus the type

type FIX is delta 1.0 range -1.0 .. 7.0;

is representable in 3 bits. As for discrete types, the number of bits needed for a fixed point type is calculated using the range of the fixed point type possibly extended to include 0.0.

- If T is a floating point type, an access type or a task type the specified size must be equal to the number of bits used to represent values of the type per default (floating points: 32 or 64, access types : 32 bits and task types : 32 bits).
- If T is a record type the specified size must be greater or equal to the minimal number of bits used to represent values of the type per default.
- If T is an array type the size of the array must be static, i.e. known at compile time and the specified size must be equal to the minimal number of bits used to represent values of the type per default.

The size given in the length clause will be used when allocating space for values of the type in all contexts e.g. as part of an array or record. For declared objects the size will be rounded to the nearest number of bytes before the object is allocated.

#### Collection size specifications:

Using the STORAGE\_SIZE attribute on an access type will set an upper limit on the total size of objects allocated in the collection allocated for the access type. If further allocation is attempted, the exception STORAGE\_ERROR is raised. The specified storage size must be less than or equal to INTEGER'LAST

### Task storage size

When the `STORAGE_SIZE` attribute is given on a task type, the task stack area will be of the specified size. The specified storage size must be less than or equal to `INTEGER'LAST`.

### Small specifications

Any value of the `SMALL` attribute less than the specified delta for the fixed point type can be given.

## F.4.2 Enumeration Representation Clauses

Enumeration representation clauses may specify representations in the range of `SHORT_INTEGER'FIRST .. SHORT_INTEGER'LAST`. An enumeration representation clause may be combined with a length clause. If an enumeration representation clause has been given for a type the representational values are considered when the number of bits needed to hold any value of the type is evaluated. Thus the type

```
type ENUM is (A,B,C);  
for ENUM use (1,2,3);
```

needs 3 bits to represent any value of the type.

## F.4.3 Record Representation Clauses

When component clauses are applied to a record type, the following should be noted:

- Components can start at any bit boundary. Placing e.g. non packed arrays on odd bit boundaries will cause costly implicit conversion to be generated, however.
- All values of the component type must be representable within the specified number of bits in the component clause.
- If the component type is either a discrete type or a fixed point type, then the component is packed into the specified number of bits (see however the restriction in the paragraph above).
- If the component type is not one of the types specified in the paragraph above, the default size calculated by the compiler must be given as the bit width, i.e. the component must be specified as

```
component at N range X..X + component_type'SIZE - 1
```

where N specifies the relative storage unit number (0,1,...) from the beginning of the record, and X is any bit number.

- The maximum bit width for components of discrete or fixed point types is 32.

If the record type contains components which are not covered by a component clause, they are allocated consecutively after the component with the highest offset specified by a component clause. Holes created because of component clauses are not otherwise utilized by the compiler.

When the compiler determines the size of a record component the following is taken into account in the specified order:

- . a component clause
- . a length clause ('SIZE) on the component type
- . a possible pragma PACK on the record type
- . the default size of the component type

#### **F.4.3.1 Alignment Clauses**

Alignment clauses for records are supported with the following restrictions:

- The specified alignment boundary must be 1,2,4,8 or 16.
- The specified alignment must not conflict with the alignment requirement for the record components, i.e. an alignment boundary of 4 is not accepted if the record has a component of an array type with size 100 bytes (such arrays should be aligned on a 16 byte boundary).

#### **F.5 Names for Implementation-Dependent Components**

None defined by the compiler.

#### **F.6 Address Clauses**

Address clauses are supported for scalar and for composite objects whose size can be determined at compile time. Address clauses are not supported for subprograms, packages, tasks or task entries.

#### **F.7 Unchecked Conversion**

Unchecked conversion is only allowed between objects of the same "size". However, if scalar type has different sizes (packed and unpacked), unchecked conversion between such a type and another type is accepted if either the packed or the unpacked size fits the other type.





## F.8 Input/Output Packages

The implementation supports all requirements of the Ada language and the POSIX standard described in document P1003.5 Draft 4.0/WG15-N45. It is an effective interface to the SunOS file system, and in the case of text I/O, it is also an effective interface to the SunOS standard input, standard output, and standard error streams.

This section describes the functional aspects of the interface to the SunOS file system, including the methods of using the interface to take advantage of the file control facilities provided.

The Ada input-output concept as defined in Chapter 14 of the ARM does not constitute a complete functional specification of the input-output packages. Some aspects of the I/O system are not described at all, with others intentionally left open for implementation. This section describes those sections not covered in the ARM. Please notice that the POSIX standard puts restrictions on some of the aspects not described in Chapter 14 of the ARM.

The SunOS operating system considers all files to be sequences of bytes. Files can either be accessed sequentially or randomly. Files are not structured into records, but an access routine can treat a file as a sequence of records if it arranges the record level input-output.

Note that for sequential or text files (Ada files not SunOS external files) RESET on a file in mode OUT\_FILE will empty the file. Also, a sequential or text file opened as an OUT\_FILE will be emptied.

### F.8.1 External Files

An external file is either a SunOS disk file, a SunOS FIFO (named pipe), a SunOS pipe, or any device defined in the SunOS directory. The use of devices such as a tape drive or communication line may require special access permissions or have restrictions. If an inappropriate operation is attempted on a device, the USE\_ERROR exception is raised.

External files created within the SunOS file system shall exist after the termination of the program that created it, and will be accessible from other Ada programs. However, pipes and temporary files will not exist after program termination.

Creation of a file with the same name as an existing external file will cause the existing file to be overwritten.

Creation of files with mode IN\_FILE will cause USE\_ERROR to be raised.

The name parameter to the input-output routines must be a valid SunOS file name. If the name parameter is empty, then a temporary file is created in the /usr/tmp directory. Temporary files are automatically deleted when they are closed.

### F.8.2 File Management

This section provides useful information for performing file management functions within an Ada program.

The only restrictions in performing Sequential and Direct I/O are:

- The maximum size of an object of ELEMENT\_TYPE is 2\_147\_483\_647 bits.
- If the size of an object of ELEMENT\_TYPE is variable, the maximum size must be determinable at the point of instantiation from the value of the SIZE attribute.

### The NAME parameter

The NAME parameter must be a valid SunOS pathname (unless it is the empty string). If any directory in the pathname is inaccessible, a USE\_ERROR or a NAME\_ERROR is raised.

The SunOS names "stdin", "stdout", and "stderr" can be used with TEXT\_IO.OPEN. No physical opening of the external file is performed and the internal Ada file will be associated with the already open external file. These names have no significance for other I/O packages.

Temporary files (NAME = null string) are created using tmpname(3) and are deleted when CLOSED. Abnormal program termination may leave temporary files in existence. The name function will return the full name of a temporary file when it exists.

### The FORM parameter

The Form parameter, as described below, is applicable to DIRECT\_IO, SEQUENTIAL\_IO and TEXT\_IO operations. The value of the Form parameter for Ada I/O shall be a character string. The value of the character string shall be a series of fields separated by commas. Each field shall consist of optional separators, followed by a field name identifier, followed by optional separators, followed by "=>", followed by optional separators, followed by a field value, followed by optional separators. The allowed values for the field names and the corresponding field values are described below. All field names and field values are case-insensitive.

The following BNF describes the syntax of the FORM parameter:

form	::= [field {, field}]*]
fields	::= rights   append   blocking   terminal_input   fifo   posix_file_descriptor
rights	::= OWNER   GROUP   WORLD => access {,access_underscore}
access	::= READ   WRITE   EXECUTE   NONE
access_underscore	::= _READ   _WRITE   _EXECUTE   _NONE
append	::= APPEND => YES   NO
blocking	::= BLOCKING => TASKS   PROGRAM



terminal\_input ::= TERMINAL\_INPUT => LINES | CHARACTERS  
fifo ::= FIFO => YES | NO  
posix\_file\_descriptor ::= POSIX\_FILE\_DESCRIPTOR => 2

The FORM parameter is used to control the following :

- File ownership:

Access rights to a file is controlled by the following field names "OWNER", "GROUP" and "WORLD". The field values are "READ", "WRITE", "EXECUTE" and "NONE" or any combination of the previously listed values separated by underscores. The access rights field names are applicable to TEXT\_IO, DIRECT\_IO and SEQUENTIAL\_IO. The default value is OWNER => READ\_WRITE, GROUP => READ\_WRITE and WORLD => READ\_WRITE. The actual access rights on a created file will be the default value subtracted the value of the environment variable umask.

**Example**

To make a file readable and writable by the owner only, the Form parameter should look something like this:

"Owner =>read\_write, World=> none, Group=>none"

If one or more of the field names are missing the default value is used. The permission field is evaluated in left-to-right order. An ambiguity may arise with a Form parameter of the following:

"Owner=>Read\_Execute\_None\_Write\_Read"

In this instance, using the left-to-right evaluation order, the "None" field will essentially reset the permissions to none and this example would have the access rights WRITE and READ.

- Appending to a file:

Appending to a file is achieved by using the field name "APPEND" and one of the two field values "YES" or "NO". The default value is "NO". "Append" is allowed with both TEXT\_IO and SEQUENTIAL\_IO. The effect of appending to a file is that all output to that file is written to the end of the named external file. This field may only be used with the "OPEN" operation, using the field name "APPEND" in connection with a "CREATE" operation shall raise USE\_ERROR. Furthermore, a USE\_ERROR is raised if the specified file is a terminal device or another device.

### Example

To append to a file, one would write:

"Append => Yes"

#### - Blocking vs. non-blocking I/O:

The blocking field name is "Blocking" and the field values are "TASKS" and "PROGRAM". The default value is "PROGRAM". "Blocking=>Tasks" causes the calling task, but no others, to wait for the completion of an I/O operation. "Blocking=>program" causes the all tasks within the program to wait for the completion of the I/O operation. The blocking mechanism is applicable to TEXT\_IO, DIRECT\_IO and SEQUENTIAL\_IO. UNIX does not allow the support of "BLOCKING=>TASKS" currently.

#### - How characters are read from the keyboard:

The field name is "TERMINAL\_INPUT" and the field value is either "LINES" or "CHARACTERS". The effect of the field value "Terminal\_input => Characters" is that characters are read in a noncanonical fashion with Minimum\_count=1, meaning one character at a time and Time=0.0 corresponding to that the read operation is not satisfied until Minimum\_Count characters are received. If the field value "LINES" is used the characters are read one line at a time in canonical mode. The default value is Lines. "TERMINAL\_INPUT" has no effect if the specified file is not already open or if the file is not open on a terminal. It is permitted for the same terminal device to be opened for input in both modes as separate Ada file objects. In this case, no user input characters shall be read from the input device without an explicit input operation on one of the file objects. The "TERMINAL\_INPUT" mechanism is only applicable to TEXT\_IO.

#### - Creation of FIFO files:

The field name is "Fifo" and the field value is either "YES" or "NO". "FIFO => YES" means that the file shall be a named FIFO file. The default value is "No".

For use with TEXT\_I/O, the "Fifo" field is only allowed with the Create operation. If used in connection with an open operation an USE\_ERROR is raised.

For SEQUENTIAL\_IO, the FIFO mechanism is applicable for both the Create and Open operation.

In connection with SEQUENTIAL\_IO, an additional field name "O\_NDELAY" is used. The field values allowed for "O\_NDELAY" are "YES" and "NO". Default is "NO". The "O\_NDELAY" field name is provided to allow waiting or immediate return. If, for example, the following form parameter is given:

"Fifo=>Yes, O\_Ndelay=>Yes"



then waiting is performed until completion of the operation. The "O\_Ndelay" field name only has meaning in connection with the FIFO facility and is otherwise ignored.

- Access to Open POSIX files:

The field name is "POSIX\_File\_Descriptor". The field value is the character string "2" which denotes the stderr file. Any other field value will result in USE\_ERROR being raised. The Name parameter provides the value which will be returned by subsequent usage of the Name function. The operation does not change the state of the file. During the period that the Ada file is open, the result of any file operations on the file descriptor are undefined. Note that this is a method to make stderr accessible from an Ada program.

### File Access

The following guidelines should be observed when performing file I/O operations:

- At a given instant, any number of files in an Ada program can be associated with corresponding external files.
- When sharing files between programs, it is the responsibility of the programmer to determine the effects of sharing files.
- The RESET and OPEN operations to files with mode OUT\_FILE will empty the contents of the file in SEQUENTIAL\_IO and TEXT\_IO.
- Files can be interchanged between SEQUENTIAL\_IO and DIRECT\_IO without any special operations if the files are of the same object type.

### F.8.3 Buffering

The Ada I/O system provides buffering in addition to the buffering provided by SunOS. The Ada TEXT\_IO packages will flush all output to the operating system under the following circumstances:

1. The device is a terminal device and an end of line, end of page, or end of file has occurred.
2. The device is a terminal device and the same Ada program makes an Ada TEXT\_IO input request or another file object representing the same device.

Please refer to Appendix E (Root Library Support) for the full specifications of all I/O packages.

### F.9 Machine Code Insertions

Currently machine code insertions are not supported.